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Queensland Sugar-cane Quarantine Districts.

By D. R. L. Steindl.

Under the provisions of the Sugar Experiment Stations Acts, the Government is enabled to proclaim quarantines; these are of two types, viz., foreign and local quarantines, and in each case the object is to prevent the introduction of a disease* or insect pest into an area where it has not previously existed. The foreign quarantine measures prohibit the haphazard introduction of foreign varieties from abroad, and in the case of Queensland the sole right of the importation of foreign cane varieties is vested in the Bureau of Sugar Experiment Stations. Varieties which are imported by the Bureau are, in the first place, obtained only from countries where competent pathologists are resident, and the disease situation is such that there is little risk of introducing a new disease. Upon receipt of the cane in Queensland it is carefully disinfected and is then grown for a period of at least one year, under the constant supervision of the pathologists. Should the cane exhibit any symptoms of disease during this period it is discarded and destroyed. Local quarantines, on the other hand, are established to prevent the further spread of diseases which have already gained entry into the country. Fortunately, the chief cane diseases are not all generally distributed throughout the State. For example, leaf-scald disease is not present south of Mackay, while gumming disease is now only known to exist in the far north. Similarly, Fiji disease is confined to the southern end of the cane belt, while dwarf disease is restricted to the Mackay district.

Since diseases are always spread from country to country, or district to district, by the transfer of diseased planting material, it is very important that plants should not be taken from a district where a particular disease is present to one where this disease is not present. Very serious consequences to the sugar industry might follow, for example, if some thoughtless person took some Fiji diseased cane from the Bundaberg district and planted it in North Queensland. Naturally, a person would not knowingly plant diseased cane, but it so happens that the symptoms of most diseases may be masked for fairly long

* Diseases may exist in strains of varying severity. For example, one of the strains of mosaic in Louisiana may be more destructive to standard varieties than the strain found in Queensland. Therefore, although a disease may already be present in this State, it is necessary to guard against the introduction of possible new strains.

periods of time and cane which is apparently quite healthy may be diseased. In order to reduce the likelihood of the industry in any particular district being jeopardised by the introduction of a new disease

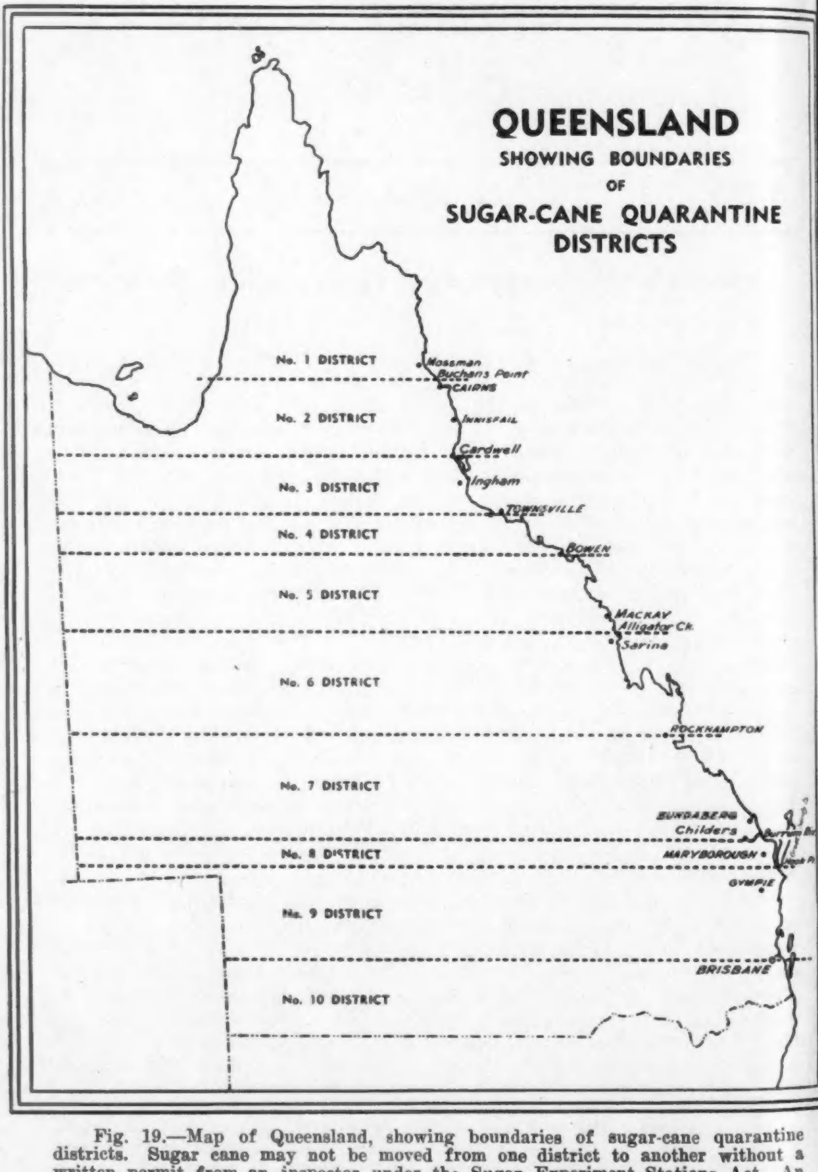

Fig. 19.—Map of Queensland, showing boundaries of sugar-cane quarantine districts. Sugar cane may not be moved from one district to another without a written permit from an inspector under the Sugar Experiment Stations Act. An exception is made in the case of cane consigned to a sugar mill for milling purposes.

in planting material brought in from another district, the State has been divided into ten sugar-cane quarantine districts. The removal of sugar-cane plants from any one of these districts to any other district is prohibited under the Act unless a permit to do so has been issued by the Bureau of Sugar Experiment Stations. The boundaries of these sugar-cane quarantine districts correspond approximately to lines drawn east and west through the following points:—Buchan's Point, Cardwell. Townsville, Bowen, Alligator Creek (to the south of Mackay), Rockhampton, Howard, Hook Point (on the southern end of Great Sandy Island), Brisbane, and the New South Wales border (see Fig. 19). The introduction of cane from New South Wales is absolutely prohibited unless a certificate as to freedom from disease has been issued by the Bureau.

In addition to the above district quarantines, small groups of farms or even individual farms may be quarantined by proclamation if an outbreak of a particular disease not present throughout the district occurs on them. For example, a recent outbreak of gumming disease in the Mossman area necessitated the quarantining of the group of farms concerned. While in South Queensland every farm on which Fiji disease or downy mildew disease has occurred during the past three years is quarantined, since no sugar cane may be removed from such farms for any purpose other than milling, unless a permit is issued by the Bureau.

These quarantines are designed for the control of sugar-cane diseases and pests, and it is therefore to the advantage of all farmers to be familiar with, and adhere strictly to them.

Cane Growers' Varietal Returns.

All cane growers are reminded that Section 16 of "*The Sugar Experiment Stations Acts,* 1900 *to* 1941," requires them each year to furnish to the mill which they supply, duplicate statements setting out areas of all varieties planted and harvested during the preceding calendar year. In addition to the varieties planted and harvested for milling, this statement should include all cane cut for plants and fodder, whether it is used on the farm or sold, together with any experimental varieties grown in trials or propagation plots for the Bureau or other authorised persons. Three copies of the necessary forms are supplied to each farmer by the mill. All these should be completed by the farmer, one kept by him for future reference and two forwarded to the mill before the date prescribed on the form. The miller is then required to submit one copy of each return to the Bureau.

During the past few years many growers have been lax in completing and returning these forms, and a number have made incomplete statements. Realising the many difficulties which have confronted the farmer, the Bureau has been very lenient up to the present time; however, a warning is now issued that all returns must be completed fully and promptly in future, and any farmer failing to do so will render himself liable to the penalty which is prescribed.

It is therefore suggested that growers make careful records now of all cane harvested and planted this year, so that they will have this information at hand when the forms are distributed early next year.

D.R.L.S.

Meeting of the Sugar Experiment Stations Advisory Board held at Brisbane, 19th August, 1946.

THE second meeting of the Sugar Experiment Stations Advisory Board for 1946 was held in the office of the Director of the Bureau on Monday, 19th August, with the Deputy Chairman, Mr. J. W. Inverarity, in the chair, since the Chairman, the Minister for Agriculture and Stock (the Hon. H. H. Collins), had to proceed to Canberra at short notice to attend a meeting of the Agricultural Council. All other members were present. Members regretted that it had so far been impossible to fill some important vacancies in the Bureau staff, and also the resignation of Mr. J. E. Tesch, assistant mill technologist, who had given promise of being a most useful officer.

The important matter of Bureau finances was discussed and it was unanimously resolved that with its increased commitments the Bureau would soon be unable to carry on, even at present strength, without increased revenue which it would be necessary for the industry to provide.

The principle that Cane Pest and Disease Control Boards should have the power to subsidise growers in matters relating to disease and pest control in their areas was also reaffirmed.

Several other cane pest and disease control measures were considered and the following resolutions adopted:—

1. That the Invicta (Ingham Line) Board be permitted to purchase a flame thrower.

2. That the Mulgrave Board pay up to 15s. per scalp for wild pigs and also pay for the collection of beetles up to a total amount of £500.

3. That the Invicta (South of Townsville) Board pay 1s. per scalp for wallabies.

Recommendations from the Queensland Cane Growers' Council arising out of the report of the recent Overseas Delegation were considered. Of these it was resolved that the Bureau give attention to the following:—

(*a*) Investigation into flame and spray cultivation;

(*b*) Investigation into the efficacy of three field implements, viz., implement for ploughing out stools, manure spreader, and disc weeder.

Consideration was given to the matter of compensating a grower for loss resulting from the establishment of a frost resistance varietal trial on his property. It was agreed that compensation was warranted in this instance.

Other matters dealt with by the Board related to vacancies on the Bureau staff, and the proposed establishment of an experiment station at Ayr.

The next meeting of the Board is to be held in November, probably in a country centre.

Forecast of Approved Varieties for 1947.

IN accordance with usual practice, the Bureau has prepared a forecast of the changes it is proposed to make in the approved variety list for 1947. Any interested farmers' organisations which consider alterations should not be made along the lines indicated, or wish to submit any other changes, are invited to submit their views to the Director of Sugar Experiment Stations before November 30th, 1946. Any objections against varietal deletions or suggestions for additions must be accompanied by a detailed statement of the reasons for such objections or suggestions. No action can be taken in respect of late or unsubstantiated requests.

Proposed changes are as follows, and, unless othewise indicated, lists will remain as in 1946: —

Hambledon.—Q.10 to be deleted.

Mulgrave.—North of Fig Tree Creek—Korpi and Q.13 to be deleted. Babinda District—H.Q.409 to be deleted. South of Russell River—H.Q.409 to be deleted.

Goondi.—H.Q.409 to be deleted.

South Johnstone.—H.Q.409 to be deleted.

Mourilyan.—Q.2 to be added.

Macknade.—Juno to be deleted.

Victoria.—Brutus, Q.813, Q.2 and Juno to be deleted.

Invicta.—Area lying south of Townsville—Trojan to be added.

Pioneer.—Trojan to be added.

Kalamia.—Trojan to be added.

Inkerman.—Q.20 to be deleted; Trojan and S.J.16 to be added.

Proserpine.—Q.50 to be added.

Farleigh.—Q.50 to be added.

Racecourse.—Q.50 to be added.

Pleystowe.—Q.50 to be added.

Marian.—Q.50 to be added.

Cattle Creek.—Q.50 to be added.

North Eton.—Q.50 to be added.

Plane Creek.—Q.50 to be added.

Bingera.—Q.47 to be added.

Fairymead.—Q.47 to be added.

Millaquin.—Q.47 to be added.

Qunaba.—Q.47 to be added.

Gin Gin.—Q.47 to be added.

Maryborough.—Pialba District—Q.25 to be deleted.

Mt. Bauple.—Q.42 to be added.

Moreton.—Q.28 to be added.

The Sugar Industries of Louisiana, Cuba and Hawaii, with Particular Reference to Mechanical Harvesting and Loading.

BY E. R. BEHNE.

[EDITORIAL NOTE.—The Queensland Cane Growers' Council decided to send a delegation to Louisiana to study mechanical harvesting at the end of 1945, and Mr. Behne was invited to accompany it. The Advisory Board subsequently recommended that Mr. Behne travel with this delegation. The following article includes Mr. Behne's report on mechanical harvesting, agricultural implements, flame and spray cultivation, with a brief summary of milling practices and the bulk handling of sugar.]

INTRODUCTION.

IN this report are given the observations and comments of the writer covering his visit to the sugar industries of Louisiana, Cuba and Hawaii. This visit was made in the company of Messrs. R. J. S. Muir, General Secretary of the Queensland Cane Growers' Council, and S. E. Toft, cane grower, who, as a delegation from the Queensland Cane Growers' Council, were proceeding to these countries to study the mechanical harvesting of cane. This subject was also the chief reason for the writer's trip.

In connection with machines and implements much of the descriptive parts of this report and that of Messrs. Muir and Toft was prepared in collaboration, consequently both reports contain sections that are similarly worded.

With Mr. Toft, the writer left Sydney on Sunday, 11th November, 1945, and returned to Brisbane on Saturday, 2nd February, 1946. Mr. Muir, who had proceeded to London earlier on other business, was joined at Baton Rouge on Sunday, 18th November. A period of two months was spent in the United States and Cuba, whilst a fortnight was devoted to Hawaii.

The subjects discussed in this report have been presented under subject headings and no attempts have been made to treat the matters chronologically. Mechanical harvesting has, in the circumstances, been given more prominence than other subjects, whilst to give an indication of the reasons underlying the adoption of certain practices in the different countries, a preliminary section is included setting out the factors which determine the policies of these countries.

FACTORS WHICH GOVERN THE POLICIES ADOPTED IN LOUISIANA, CUBA AND HAWAII.

Although the production of sugar from sugar cane is basically the same in all sugar producing countries the practices may vary considerably amongst them. Each country has its own set of conditions—climatic, agronomic, social, political and economic—and the policies of the industries are governed entirely by the combined effect of these individual factors. This was clearly demonstrated in the sugar industries of the three countries visited, viz., Louisiana, Cuba and Hawaii. Hence before true comparisons may be made between the equipment and methods used in these countries, it is essential that the conditions under which they operate should be clearly understood.

(a) Louisiana.

In Louisiana climate is the dominating feature. In about three years out of five severe freezes occur at the end of November, when the temperature may record as low as 20 deg. F., but the industry is faced with the possibility of the occurrence each year and so is forced to take all necessary precautions. In other words, each year it prepares for the worst and hopes for the best.

The influence of this freeze is far reaching. Sugar cane is essentially a tropical plant and has litle inherent resistance to extreme cold—consequently any cane that is standing at the onset of this severe weather is doomed unless it can be taken off and more or less preserved in the frozen state. A practice which has been found reasonably satisfactory in Louisiana is to "windrow" the cane. Immediately a freeze is predicted as much of the cane as possible is cut and laid along the interspaces so that the tops (which are not severed) provide a complete cover for the sticks. Cane thus "windrowed," though frozen, will not deteriorate to the same extent as standing cane.

Further, all young cane, either plant or ratoon, will be cut back by the freeze and the crown thereafter will remain dormant till the return of warm weather—usually the following February. Obviously any cane planted just prior to the freeze will also remain dormant over the same period. From this it is at once clear that the entire crop is virtually grown and harvested between February and November—a matter of a mere ten months. The mills, of course, crush "windrowed" cane once the freeze occurs and may continue into January.

The influences of this strictly limited time factor are:—

(i.) The cane never reaches maturity. The average pol in cane for a season is in the vicinity of 10 per cent. whilst the purity of the juice rarely exceeds 80 per cent. With a fibre per cent. cane from 13 to 14 the corresponding average C.C.S. would be just over 8 per cent. The average C.C.S. value in Queensland is approximately 15 per cent. and cane with values below 7 per cent. may be rejected by the mills. When one reflects on this single difference one must realise that sugar manufacture in Louisiana and that in Queensland are widely differing propositions.

(ii.) Speed of harvesting and milling are of prime importance. Obviously the more cane that is milled before the freeze, the less there is to "windrow" and the smaller is the risk of loss. Consequently any factor which has a tendency to slow down operations is eliminated or reduced to a minimum. Even efficiency of operation is sacrificed in the interests of speed, e.g., the average coefficient of work would be between 91 and 92.

Crushing rates in most cases are high. As an instance, the Breaux Bridge Factory, with a 48-inch crusher and four 48-inch mills, averages about 60 long tons of cane per hour at 12 per cent. fibre. The peripheral speed of the rollers is about 55 feet per minute—or just double the normal Queensland value. It was learned that a new plant was being designed to operate at a roller speed of 70 feet per minute.

Apparently the short crushing season does not warrant large capital expenditure, and relatively small milling trains running at high capacities are favoured. Extraction, of course, suffers and reduced extractions higher than 92 are uncommon.

The remaining factors all add their quota of influence. The soil, though exceedingly fertile, is stiff and clayey. This necessitates the growing of the cane along the tops of ridges some 15 inches above the level of the interspaces in order to provide drainage. This method of "ridge"-cultivation obviously places definite limitations on the type of field transport that may be used. Since mechanical loading of cane is greatly influenced by the mode of cane transport this practice will be dealt with in more detail later.

Socially the growers appear to be much more co-operative than is usual in Queensland. Possibly this attitude has developed from sheer necessity and individualism has had to be sunk in the interests of quick harvesting under conditions of labour shortage. With mechanical harvesting the contract system has been adopted on a fairly wide scale with evident satisfaction, and the willingness of the growers to co-operate in this manner has played an essential part in the successful development of mechanical harvesting in Louisiana. This fact must not be lost sight of when mechanical methods for cutting and loading in Queensland are considered.

The political and economic aspects of the industry, though obviously important, are not the concern of this investigation. Suffice it to record that on the economic side it would be impossible for the industry to function without very substantial financial aid from the Federal Government.

(b) Cuba.

In this country the predominant feature is economic, since Cuba is essentially producing for export. Cuba is ideally situated climatically for the production of sugar and with the present equipment is capable of producing up to six million tons of sugar per season. In accordance with the International Sugar Agreement, Cuba reduced its quota to no more than 50 per cent. of this amount. The technical result of this is that the milling and agricultural practices have not been developed to the stage of efficiency that would have been the case had there been the incentive to increase production.

Under present conditions with a world shortage of sugar it might be thought that Cuba could immediately swing into full production. Discussions with executives there indicated that unless some financial guarantee were made regarding the production over a period of at least five years, the industry was loth to run the risk of serious over-production.

(c) Hawaii.

Here social considerations appear to exert the greatest individual influence. For many years the necessary labour has become increasingly more difficult to obtain, and the plantations have been forced to extreme measures to counteract this. The climate is so uniform that it is possible to harvest throughout the year. (Compare this with conditions in Louisiana.) Consequently many of the factories crush practically all the year round in order to keep their labour in employment. Elaborate social amenities are provided for the employees to induce them to remain in the industry, whilst mechanical devices have been introduced widely in order to make the work lighter. For many years a special committee to deal with labour saving devices has been operating. This committee has done a considerable amount of developmental work on the grab and rake harvesting methods now so widely used. Everything has been

directed not so much to reduce cost, as to reduce labour requirements and to make the work easy.

The equable climate enables cane to continue growing throughout the year so, on the average, 24 months' crops are harvested. By the same token there is no well defined stage of maturity as is the case in Queensland. This places no restrictions on the time of the year for harvesting and a growing period of about two years appears to offer the best yields per acre. The fertile soil and large application of water (either by rain or irrigation) result in very heavy crops—frequently over 100 tons of cane per acre and up to 10 tons of sugar per acre. As will be seen later, such heavy crops are extremely difficult to harvest satisfactorily by mechanical means.

The influence of these factors on the milling of the cane is very marked. Firstly the lengthy season enables a lower rate to be adopted, so that, generally speaking, the equipment of the various stations is not used to as high a capacity as in other countries. Secondly the large quantities of extraneous matter introduced by the drastic harvesting methods have necessitated the installation of cane cleaning plants and have appreciably affected the recovery of sugar.

General.

From the above remarks it may be seen that in the three countries visited there is a different controlling factor in each instance, with the result that different methods have been imposed on the individual industries. It is interesting to note in comparison that the Queensland industry is not dominated by any one particular factor. Except during the war period, labour shortages are not serious normally; the climate, though not as equable as that of Hawaii, does not impose the severe limitations as does that of Louisiana, whilst overproduction, though normally a problem, has not caused the drastic restrictions operating in Cuba.

There are, however, several factors which do materially influence the Queensland industry, though their influence is not nearly as dominating as, say, the climate of Louisiana. These influences are social and climatic. The former refers to the small farm system and the latter to the continental climatic conditions, which result in the cane having a very marked period of maturity. These two factors combine to restrict the harvesting to the July-December portion of the year. Even then the sugar content of the cane at the beginning and end of this period is relatively low, and elaborate cane payment and harvesting systems have been introduced in order to give an equitable monetary return to each grower.

MECHANICAL HARVESTING.

In Cuba mechanical harvesting has not been introduced whilst in Hawaii conditions are so different from those in Queensland that their drastic methods are not applicable to conditions here. Consequently, except for a brief account of Hawaiian developments, attention will be focussed on the methods and equipment of Louisiana.

Louisiana.

In Louisiana the degree of development of mechanical harvesting may be gauged from the fact that some 400 mechanical harvesters and 2,000 mechanical loaders are in operation, whilst machinery manufacturers are building new machines as fast as they are able. At present

2,000,000 tons of cane (or about 50 per cent. of the crop) are cut mechanically and over 3,000,000 tons, or 80 per cent., mechanically loaded.

Harvesting comprises the cutting of the crop, the loading of the cut sticks and the transport of the cane to the factory for treatment. With mechanical harvesting the mode of transport from the field to the factory assumes far greater significance than it does with manual methods, in that it places certain limitations on the method of loading, which in turn may impose certain restrictions on the machine which does the cutting. For this reason it is desirable first to consider briefly the transport system.

Transport.

The mode of transport invariably adopted where mechanical loading is practised in Louisiana (and therefore the main method of transport there) is by tractor- (or mule-) drawn carts, and large semi-trailer motor vehicles.

The tractor- (or mule-) drawn carts (Fig. 20) are mounted on two large pneumatically-tyred wheels and have high sides. Usually two carts are drawn by one tractor and the number of units depends on the speed of loading and the length of the haul. Each cart carries two to three tons of cane.

Where the field being harvested is only a few miles from the mill the tractors haul the carts directly there, but when the distance is greater the cane is transferred to large semi-trailer motor trucks each with a capacity of 12 to 14 tons (Fig. 21). Just as in Queensland, derricks situated at strategic points throughout the area are used to effect the transfer from the small to the large vehicles. A typical derrick is shown in Fig. 22.

This system of transport is exceedingly flexible, whilst the carts are able to traverse headlands and fields with great facility; with cheap fuel and the bitumen highways of Louisiana, the system is ideally suited to the task. Previously, it is understood, tramway systems were common in Louisiana, but these have now almost entirely been superseded by the motor transport. Indeed, in a distance of 1,500 miles travelled through the cane lands, on only one occasion did the delegation see tramway transport.

One objection to motor transport is that the unloading at the mill is not as simple as with tram trucks. In Louisiana, the difficulty is overcome by unloading the vehicles at the factory by means of a crane and dumping the cane into a large pile adjacent to the carrier (Fig. 23). During the day this pile is built up to provide the cane supply for the night. There are obvious objections to this practice in Queensland.

Cane Cutting Machines.

Three main types of cane cutting machines were seen in operation: Thomson (Hurry-Cane), Thornton and Wurtele. The first two only cut the cane, whilst the Wurtele makes provision for loading directly on to trucks. All three machines utilise the same principles of gathering, topping and cutting; i.e., the cane is gathered by chains with finger attachments, the tops are removed by a rotating disc or discs, and the butts are severed in the same way. The principal differences occur in the subsequent handling of the cut sticks.

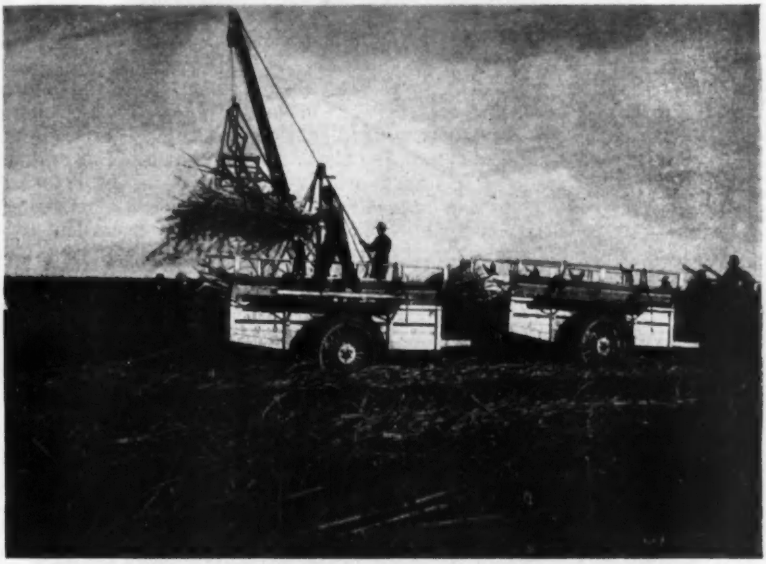

Fig. 20.—Tractor-driven carts, carrying about two tons of cane each, commonly used in Louisiana.

FIG. 21.—Semi-trailer motor truck, carrying 12-14 tons of cane, as used in Louisiana.

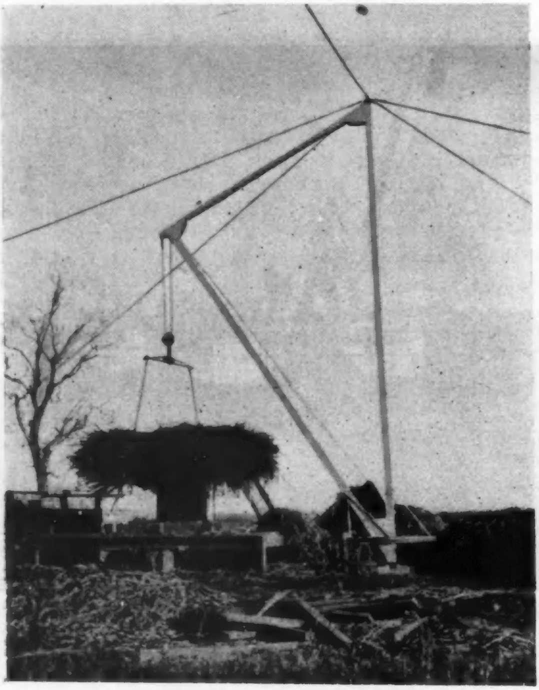

Fig. 22.—Cane derrick, Louisiana.

Fig. 23.—Cane pile at Mill, Louisiana.

Detailed descriptions of the three machines are set out hereunder:—

1. *The Thomson (Hurry-Cane) Harvester.*

This machine (Figs. 24 and 25) is a single-row integral machine, and is powered by an Allis-Chalmers tractor engine of 40-50 h.p. This engine drives the cutting mechanism and also provides the power for locomotion. Various models of the machine were seen, each differing slightly from the others, and in a discussion with Mr. Thomson at his factory at Thibodaux it was gathered that finality of design was not yet achieved, although most of the machines in operation were of his make. It is understood that this machine was the logical development of the Munson-Thomson mechanical windrower, described by King in his report to the Queensland Society of Sugar Cane Technologists, 1939.

Fig. 24.—Front view of Thomson (Hurry-Cane) Harvester in operation, Louisiana.

The frame, mounted on four pneumatically-tyred wheels, is of tubular steel construction, welding having been used throughout.

The standing cane is gathered in the usual way between two moving chains, with finger attachments. These operate about three feet above the ground, and as the stalks feed into the machine the tops are severed by a rotating disc or discs, fitted with sharp triangular-shaped teeth $1\frac{1}{2}$ inch to 2 inches long, with a pitch of six to eight inches. The discs are mounted on vertical shafts which may be raised or lowered to conform with cane of different heights. The tops are guided into position for cutting by means of a screw-shaped rotor, which also assists in discarding the tops when severed. Simultaneously, the butts of the sticks are severed by a single rotating disc similar to those used for topping. The severed and topped sticks are then carried, upright and with butts resting on the ground, through the machine to the rear, by means of a horizontal chain fitted with sharp teeth and bearing against a spring-mounted runner. At the rear of the machine the stalks, still

upright, are turned at right angles and then carried laterally across the rear by another similar chain arrangement, which is extended about eight feet beyond the side of the machines. This extension is hinged and may be folded back along the side of the harvester to facilitate road travel.

The function of this extension (Fig. 25) is to enable three rows of cane to be deposited in the one layer when cut, and it operates as follows:—

As the machine passes down the first row, the cane, after turning the corner at the back of the machine, is deposited over the first interspace, through a hinged gate immediately over that interspace. Before

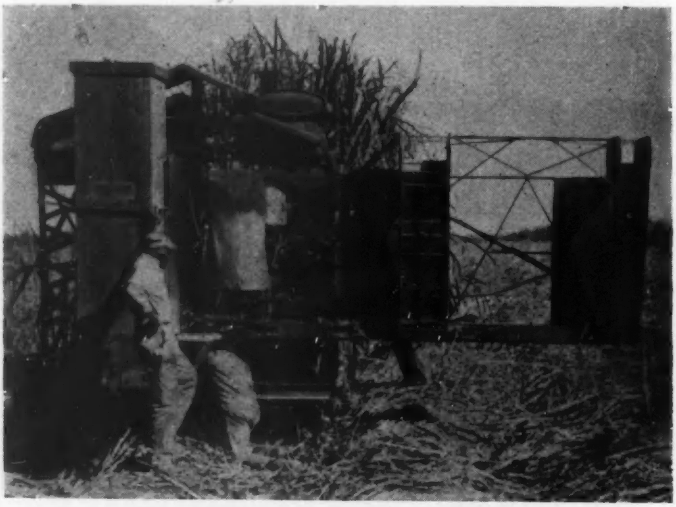

Fig. 25.—Rear view of Thomson (Hurry-Cane) Harvester, showing cane distributing extension, Louisiana.

the next row is cut, this gate is closed and a second gate six feet further out is opened and the second row is deposited on top of the layer from the first row. The third row of cane is carried past the two gates (now both closed) and dropped from the end of the extension and again on to the layer formed from the two previous rows. Thus a compact layer from three rows of cane is formed across one interspace (Fig. 26).

Since with Louisiana loading practice it is essential to lay several rows of cane across the one interspace for subsequent mechanical loading, the advantages of this method of delivering the cane are readily apparent.

This harvester impressed the delegation more favourably than did either of the other types. Although the design is not yet finalised, each unit is a finished product, and well constructed.

It has several disadvantages, however, viz.:—

(*a*) Two or three rows of cane require to be hand cut before the machine may enter a block;

(*b*) The tops from one row of cane are dropped beneath each layer of cane, and a proportion of these are picked up in the subsequent loading operations;

(*c*) Mechanical perfection has not been achieved, as it was noted that all machines inspected were stopped frequently as the result of chokes, etc.

Fig. 26.—Layer of cane from three rows deposited across one interspace, with Thomson loader in background, Louisiana.

The price of this machine in Louisiana is given as 7,500 dollars. It will harvest about one acre to one and a quarter acres per hour.

2. *The Thornton Harvester.*

This machine is built on to a light tractor which is driven backwards, the gear box, control and steering having been altered to permit this. It is a single-row cutter, and gathers the cane and tops it in a manner similar to that of the Thomson, but the butts are severed by two rotating discs. After the cane is topped and cut, the sticks are simply dropped in a continuous stream along the tops of the ridges more or less parallel to the row.

It is of light but sturdy construction, and the small number of moving parts is an advantage in keeping the machine in continuous operation.

The chief (and a serious) disadvantage lies in the fact that the cut cane has to be picked up and placed across the interspace by hand before the loading may be commenced. One contractor stated that he required 14 men per machine for this work.

Its chief advantage lies in its simplicity and the fact that it can enter a block without first having any rows hand cut.

Fig. 27.—Wurtele topping machine, Louisiana.

The cost, inclusive of the tractor, was given as 4,000 dollars. The ground speed of this machine is similar to that of the Thomson; consequently, about one to one and a quarter acres per hour can be cut.

3. *The Wurtele Harvester.*

The problem of harvesting cane has been treated by Mr. Wurtele in a manner somewhat different, in that he separates the topping and cutting, and so provides two separate machines for these two operations. The first machine, which may be termed "the topper" (Fig. 27), is an integral machine of tubular construction, mounted on four pneumatically tyred wheels. It consists essentially of a high framework carrying one set of topping discs and arrangements for the partial stripping of the adhering trash, one row of cane being treated in each traverse.

The machine straddles the row and the stalks are directed into the centre by guide bars. A typical rotating disc severs the tops, care being taken to avoid cutting too low. The consequence is that a small portion of the top is usually left on the stalk. At the rear of the machine are revolving wheels carrying flexible wire projections, and as these pass the stalks some of the trash is pulled off. An attempt had been made to incorporate a device for chaffing the tops as they were removed, but it was gathered that this had not been very successful. This machine was not seen in operation, as the only one encountered was broken down at the time of the visit.

Fig. 28.—Cane with trash and tops partially removed by Wurtele topping machine, Louisiana.

As a result of the operation of this topping machine the cane is left standing with the tops and adhering trash partially removed (Fig. 28). The harvesting machine (Figs. 29, 30 and 31) then follows. This machine is built on to a tractor, but it is understood that Mr. Wurtele is building a new model in which a tractor engine will be incorporated as an integral part of the machine. One of the existing machines was seen in operation. It incorporates the usual gathering device of chains with attached fingers. The gathered cane is then grasped firmly between chains and the small amount of top left by the topper is severed by a rotating disc. (On some models two discs are used.) The butts are cut by a large serrated disc.

The chains gripping the stalks travel upwards to the rear of the machine and so lift the stalks to a height of about two to four feet and deposit them on to an inclined platform rising to a height of about ten feet on the side of the machine opposite to the cutting mechanism (Fig 30). Travelling up this inclined platform are several conveyor chains fitted with fingers and these carry the stalks up and drop them over the outer edge on to trucks travelling alongside the machine. This

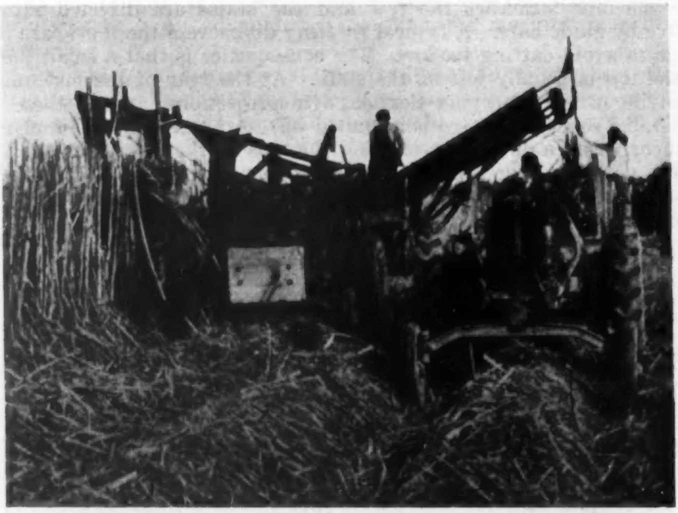

FIG. 29.—Front view of the Wurtele Harvester in operation in cane shown in Fig. 28, Louisiana.

platform is about 18 feet long and extends about twelve feet beyond the side of the machine. As the stalks, gripped by the chains, pass through the machine in an upright position, crank driven fork-shaped arms operating from the outside are provided to remove further trash by a combing action.

Fig. 30.—Rear view of Wurtele Harvester showing inclined platform and, at right, the combing mechanism, Louisiana.

Fig. 31.—Side rear view of Wurtele Harvester, showing inclined platform, Louisiana.

This apparatus appeared to be performing satisfactorily, but it is very unwieldy and the large over-hang of the platform renders a rigid construction difficult of achievement. Two men are required to adjust the cane on the conveyor. Maintenance on this machine would be high. Furthermore, four rows of cane are required to be hand-cut before the harvester can enter a block. To reduce the labour associated with the latter operation, Mr. Wurtele has built a tractor-drawn truck with an attached elevator (Fig. 32). The men simply drop the cane

FIG. 32.—Wurtele self-loading cane truck, Louisiana.

as they cut it into the bottom of the elevator (about two feet above the ground), which raises it and dumps it over the side and into the truck. The elevator is operated from the power take-off of the tractor.

Thus, Mr. Wurtele actually has three machines, and these, combined with four wagons for the transportation of the harvested cane, involve an outlay of something like 20,000 dollars. A total of fourteen men is required and up to 140 tons of cane per day may be cut and hauled to the delivery point.

Comments on Mechanical Cutters.

There are at least seven points which must be considered when attempting to determine the value of a harvesting machine. These are—

(i.) Quality of cutting.
- (a) Topping;
- (b) Ground cutting;
- (c) Trash removal.

(ii.) Speed of cutting.

(iii.) Versatility.

(iv.) Method of cane delivery by the machine.

(v.) Simplicity and robustness.

(vi.) Cost.

(vii.) Labour involved.

Finally, when all these points have been analysed and the capabilities of the machine have been assessed, there is still one aspect that must be considered. This is the applicability of the equipment to the specific task. This feature, though of vital importance, is frequently ignored.

The three Louisiana machines will now be compared with the leading machines developed in Queensland (the Toft and Fairymead machines) by an analysis of the seven points enumerated. In Appendix I to this report are given brief descriptions of the Toft and Fairymead machines.

(i.) *Quality of Cutting.*

(a) Topping.—The three Louisiana machines and the Fairymead machine all perform what may be termed "average" topping. By this is meant the removal of the tops at a point which is set for the average height of the stool. Where the sticks are of uniform length, as is the case to a remarkable degree in Louisiana, this method is quite satisfactory. Where there is lack of uniformity, as occurs frequently in Queensland, this method leaves much to be desired, and the Toft machine, which provides for the topping of each stick individually, will give best results.

(b) Ground Cutting.—In practically every instance the ground cutting observed in Louisiana was poor—stubble as long as four inches being left (Fig. 33). Local technicians advised that the machines could readily be set to cut as low as was desired but that when this was done the frequency of breakages was greatly increased. It was therefore preferred to sacrifice cutting efficiency for continuity of operation.

In Queensland, where conditions do not place so much emphasis on speed, good ground cutting is demanded and machines are expected to perform as well as hand cutters in this respect. Under reasonable conditions they appear to do so; consequently, from this aspect the Queensland machines appear to be better than the Louisiana machines.

(*c*) Trash Removal.—It is generally agreed that cane needs to be burnt for mechanical cutting and consequently the quality of the burn governs largely the amount of trash left on the cut sticks. In this regard the characteristics of the cane variety play an important part.

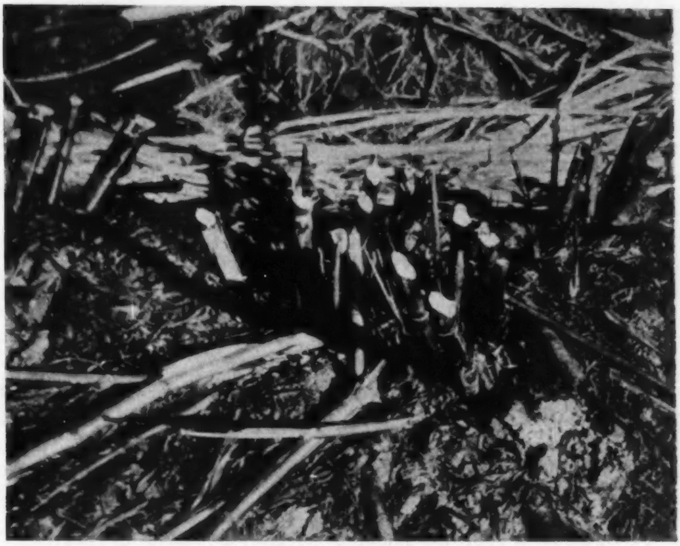

Fig. 33.—Illustrating the result of poor ground cutting by a mechanical harvester in Louisiana.

In Louisiana, all cane is cut in the leaf because it is too green to burn effectively. The cut cane is then burnt on the ground and this method appears to give good results. Of course, in wet weather no burning is possible, and since neither the Thomson nor the Thornton machine has provision for trash removal it follows that with these any trash not removed by burning is ultimately loaded and transported to the mill. Since the Wurtele machine loads directly into the transport vehicles as it cuts, no burning is possible. Hence in both the topper and the cutter, moving fingers are provided to strip the sticks. This is only moderately successful, so that some trash invariably goes to the factory with cane cut by this machine.

(ii.) *Speed of Cutting.*

The speed of cutting is best measured by the area covered in a given time since tonnages would be influenced mainly by the size of the crop. All machines travel at about the same ground speed; consequently, the machine with the highest capacity is the Fairymead two-row machine —all the others are single row machines. This machine will cut over two acres per hour, or approximately twice as much as the others.

(iii.) *Versatility.*

By this is meant the ability to treat canes of widely different characteristics, and also the manoeuvrability.

No machine has yet been developed that will treat effectively cane which is not standing more or less erect. As already mentioned cane in Louisiana is remarkably uniform in height, whilst the sticks are straight and generally of medium thickness. The performance of these machines on thick barrelled cane is thus not known. All three Louisiana machines, however, have an undesirable feature, which is shared by the Fairymead machine. This is the firm gripping of the sticks by chains. It seems that some adjustment would be necessary when changing from one cane to another when the thickness of the stick changes markedly. Possibly the spring-mounted runner of the Thomson machine would obviate this, but no information is available on this point. The Toft machine, however, does not grip the sticks and so can handle, equally well, canes of any thickness.

As regards length of stick, all machines appear to have the same range of application.

Manoeuvrability is important and here there are some distinct differences. The Thomson, Wurtele and Toft machines all require one to four rows to be hand cut before they may enter a field. The Thornton and Fairymead do not. This is an important point.

(iv.) *Method of Cane Delivery by the Machine.*

The manner in which the cut sticks are delivered by the machine is very important since the next field operation—the loading—is largely affected.

Here the machines of Louisiana differ considerably from those of Queensland—each having been developed to suit the methods of loading practised. The Queensland machines drop the sticks in more or less compact bundles which lie parallel to the direction of travel. The Wurtele loads direct into trucks travelling alongside. The Thornton simply spills the cane in a continuous line. The Thomson is the only one of them that provides for efficient subsequent loading. It performs this function exceedingly well and for the Louisiana method of loading (see later) is probably as effective as any method yet devised.

(v.) *Simplicity and Robustness.*

Simplicity and robustness are two most important factors for farm equipment, since complicated mechanisms are easily upset and require skilled servicing such as is not readily available on the farm, whilst the need for strength requires no emphasis.

One of the difficulties in the way of the designer of mechanical cane cutters is the fact that the machine must be strong and rigid but at the same time not unduly heavy; also, careful thought must be given to balance, since there are no solid foundations to absorb unbalanced stresses.

It follows from this that the simpler the mechanism the easier it is to make it strong without adding too much weight. At the same time simplicity must not be achieved at the expense of effectiveness. For example, the Thornton is the simplest of the machines, but it merely cuts the cane and so does only half the task.

The complication of the simultaneous cutting and loading in the case of the Wurtele machine makes this a cumbersome unit with many additional moving parts. Similarly, the Toft machine with its topping device suffers in this regard, whilst the Thomson, due to its stacking mechanism, does not entirely escape. In all, the Fairymead machine with the fixed shear blade appears to be the best in this respect, although frequent sharpening of the blade is necessary.

(vi.) *Cost.*

Comparisons here are difficult, as the cost of a machine varies inversely with the number produced. The prices charged for the various machines are as follows:—(N.B. The values for the American machines have been converted to Australian money at the current exchange rate of $3·27 to the pound.)

Machine.	*Price in Country Where Used.*
Thomson	£2,293
Wurtele	£2,600 (cutter only—estimated)
Thornton	£1,223 (with tractor)
Toft	£1,800 (estimated)
Fairymead	(not determined)

These values indicate that the Queensland machines, in spite of the fact that they are still virtually in the experimental stage, compare favourably with the machines in Louisiana.

(vii.) *Labour.*

Two men are required to operate the Thomson, Fairymead, and Toft cutting machines. The Thornton requires only one, but a large gang is necessary to pick up and stack the cane when cut, whilst the Wurtele uses four. Admittedly the latter also loads the cane, but this can be done in Louisiana by one man (see the Barras Loader).

On this point then, the two Queensland machines and the Thomson are similar.

Summary.

In the above comparison the seven points enumerated have been considered in detail and the conclusion to be drawn is that the Queensland machines compare more than favourably with those of Louisiana. Of the latter, the Thomson is the most outstanding and particular reference is made to the device for delivering the cane from three rows into a single layer. This machine is the most popular, by far, in Louisiana.

So far the machines have been compared simply on their capabilities as cane cutters. This is by no means the only aspect, as was intimated at the beginning of this section, for the question of applicability to local conditions must be considered. This is a problem which Louisiana has overcome, but one which the Queensland industry is just beginning to face. So important is this point, that it will be dealt with in a separate section, which, since mechanical loading is equally concerned, will be reserved till the loaders have been considered.

Loading Machines.

The mechanical loading of cane is by no means a new development in Louisiana. Records show that as early as the first decade of this century loading machines were in use there. (Indeed, the Fairymead Sugar Co. negotiated for the introduction of one of these machines into Queensland over 30 years ago.)

With such a long period of development in a country where coloured labour was abundant till comparatively recently, the machines were simple and even crude, whilst labour saving was not of primary importance.

During the war period labour shortages led to the development of new types of machine. These, however, have not yet reached the stage of large scale production and the majority of the machines in use, totalling more than 2,000, are still of the old type—chiefly the Castagnos. In all, these machines handle up to 80 per cent. of the Louisiana crop.

Because of the deep interspace between the cane rows, the cane when cut is placed across the drills, generally in the form of a continuous layer extending the length of the field, each layer being made up from three to four rows of cane. Prior to loading (except in the case of the Barras and Thomson loaders—see later) a simply constructed machine known as the bundler, or piler, is used to rake the layers of

FIG. 34.—Simple cane bundler or piler, Louisiana.

cane into a series of bundles, each of three to four hundredweight. These bundlers, in most cases, are made by the individual farmers, and so vary considerably in appearance and construction although conforming to a general principle. A brief description is as follows:—

Cane Bundler.

The bundler or piler (Fig. 34) consists merely of a rake similar to one jaw of a loader grab of the type used in Queensland, attached to a frame carried on two wheels set wide apart. The machine has a pole and wide cross bar attached and is drawn by two mules yoked so that they each walk outside the lying cane. The driver lifts and lowers the rake manually by means of a simple hand lever. In operation, when a sufficiently large bundle has been raked together, the rake is lifted clear and dropped to collect the next bundle. This machine is often worked both ways along the line of cane, in order to make very neat heaps. The practice of laying the cane across the deep interspaces greatly facilitates the operation of this implement.

The loading machine then follows and transfers the bundles in turn from one row into the wagon travelling alongside. These wagons are of box construction and the cane is spilled lengthwise and not very compactly. However, under Louisiana conditions this method is eminently satisfactory, and it is difficult to see how a better method could be developed for such conditions.

Since the mechanical harvesters so far developed in Queensland already deliver reasonably good bundles, which, to suit Queensland loading conditions, lie parallel to the line of cut, these bundlers would find little or no application in this connection. On the other hand, with manually cut cane they have definite possibilities. A method of cutting rapidly developing in Queensland is for the cutter to throw the cane from three rows on to a single continuous layer across the drill. Whilst this method cannot be recommended, as it leads to topping on the ground (generally associated with poor topping), it is nevertheless a speedier method and under present conditions of labour shortage is being tolerated in the interest of maximum output per man-hour. With cane laid in this manner, it would seem to be a simple matter for a Louisiana-type bundler to pile the sticks into bundles suitable for mechanical loading into trucks. It is, however, doubtful whether short cane could be very successfully handled in this manner. The use of the bundler therefore offers twofold possibilities: (1) more rapid manual cutting and (2) expeditious loading by mechanical loaders operating under virtually ideal conditions, particularly where portable tramline is not used in the field. This saves the cutter the task of manually loading the trucks and would enable men of lower physical standard to be employed, thus extending the pool of labour available for this class of work. With this set-up the task of manual cane cutting would be relieved of most of its objectionable features.

The Castagnos Loader.

This is a very simply constructed machine (Fig. 35) and for years has been the one most widely adopted. There are in the vicinity of 2,000 Castagnos machines in operation at present, the cost in America being $1,200. The machine is essentially a motor driven jib crane mounted on a flat wooden decking carried by four steel or pneumatic tyred wheels and drawn by tractor or mules. To facilitate turning, the two front wheels are mounted on a turntable. A 9 h.p. single cylinder kerosene engine is mounted on the decking and drives, through a counter shaft, a main shaft to which are attached two winding drums, each having a clutch and brake. One drum is for the purpose of closing the grab and lifting the bundle whilst the other opens the grab and carries it when empty. The centre pole and boom are mounted at the right centre of the machine, and the operator, who works the clutches and brakes while standing on the decking, also swings the centre pole and boom by means of a short lever bar attached. In this he is assisted by the pull on the lifting rope which passes through an idler pulley slightly to the right of the base of the centre pole and boom, and so provides a turning moment. In this way the bundle, when lifted, is easily swung to the right for dropping into the wagon. A rope is attached to the grab, and by pulling on this an operator walking with the machine assists in the return of the grab for the next bundle (Fig. 36). The operation of this loader is simple and speedy and with seven men it will load approximately 250 tons per day of eight hours.

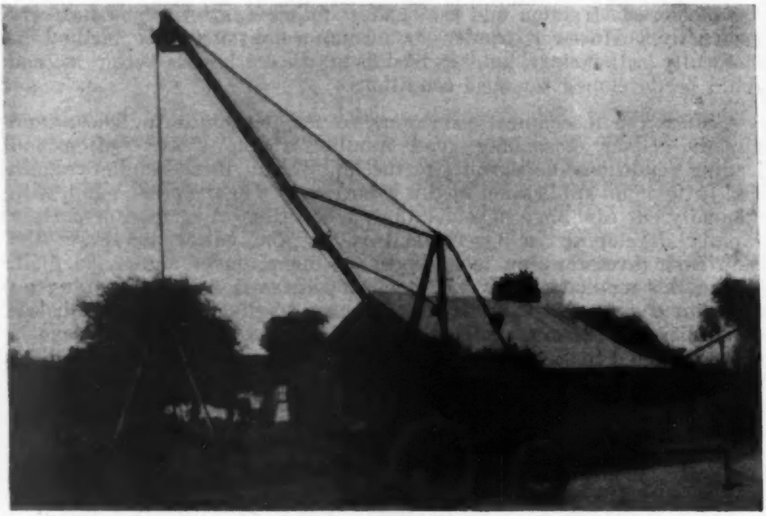

Fig. 35.—Castagnos Loader. This is the loader most widely used in Louisiana, and was fully reported upon by the 1938 Delegation to the I.S.S.C.T. Conference.

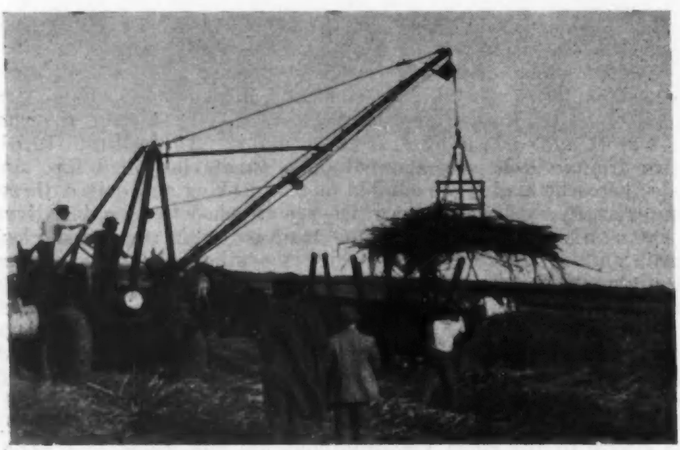

Fig. 36.—Castagnos Loader in operation, Louisiana.

The Howard Loader.

The Howard Loader (Fig. 37) is very similar in construction to the Castagnos machine. The chief difference lies in the mounting of the centre pole and boom, which are carried at the apex of a triangular extension supported by a castor wheel. This fifth wheel lends stability to the machine, and saves it from any tendency to tip when the load is being carried.

The Barras Loader.

This machine (Fig. 38), which has only recently been developed, is self-propelled and, as already indicated, does its own bundling. The petrol motor providing power for both the loading and the movement of the machine is mounted on the left side midway between the wheels. At the rear in a covered compartment are the gears and winding drums,

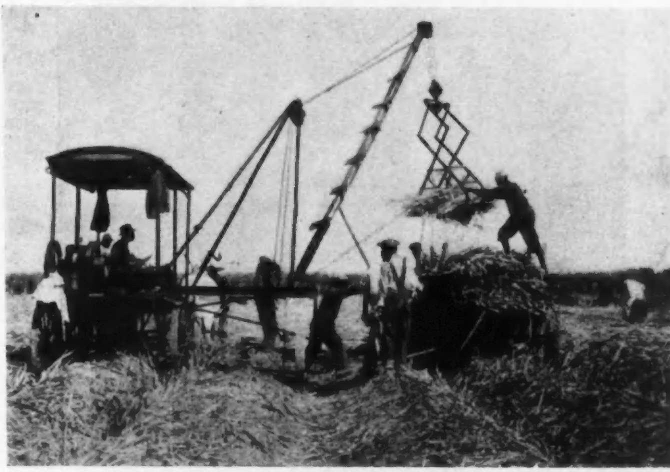

FIG. 37.—Howard Loader in operation, Louisiana.

whilst in the front is the operator's cabin provided with glass windows. Attached at the front right corner is the self bundling device operating as a push rake. This consists of two mild steel plates, suitably braced, mounted vertically and about three feet apart and attached to the front cross bar of the machine by a steel framework, the mounting of which is in the form of a hinge to enable the attachment to be raised for travel. The top edge of each plate, which extends about 20 inches above the ground, is flared out, whilst the forward edge is curved, providing a small overhang at the top, and the bottom extends about 18 inches in the form of a tyne. In operation the operator drives the machine along the drill over which the layer of cane has been deposited. The tynes pass below the sticks, which are then carried forward by the curved forward edges of the plates, until a sufficiently large bundle has been made.

The boom which carries the lifting grab is mounted at the right front corner of the machine. Attached to the grab is a tubular yoke the centre of which is connected to a rod passing through a pipe-like socket pivoted in the centre of the boom. This attachment keeps the

Fig. 38.—Barras Loader, Louisiana.

Fig. 39.—Grab on Barras Loader, Louisiana.

grab always at right angles to the boom. The lifting rope is attached to the grab to the rear of the centre so that when the grab is open the forward jaw hangs lower than the rear one (Fig. 38). Thus, when the open grab is dropped on to the cane which the push rake has piled up, the teeth of the forward jaw penetrate through the layer. The continued forward movement of the machine forces the bundle into the curve of this jaw. The rear jaw is then released and falls through the clear place behind the bundle and between the vertical plates of the bundling device. The closed grab is then lifted and swung 90 deg. to

Fig. 40.—Turning drum on which is mounted the boom of the Barras Loader, Louisiana.

the right and the load dropped into a box cart travelling alongside. As the grab is being swung back to the front the machine moves forward to form the next bundle. To avoid tipping, a counterpoise is mounted at the corner of the machine diagonally opposite to that where the boom is situated. The boom is swung by a wire rope passing round a drum at the base of the boom (Fig. 40) and connected to a winding drum in the rear compartment of the machine. This rope also passes round a second drum to which the counterpoise is attached. In this way the direction of the counterpoise is always parallel to that of the boom.

The unit seen was very well constructed and was mounted on pneumatic tyres. Two men only are required, one operating the loader and the other driving the tractor hauling the cane wagon, and 350 tons of cane per day may be moved.

The delegation had a discussion on this machine with the inventor, Mr. Barras. He advised that the cost at present in America was $6,500, but he hoped to reduce this to about half when he could arrange for units to be made in large numbers.

The Thomson Loader.

Though this machine is still in the developmental stage and the final design has not yet been established, it shows considerable promise. Like the Barras it does its own bundling, but unlike the Barras it does it with the grab, which, instead of being lifted by ropes, is attached direct to the end of the boom and is of special design. The boom is mounted low at the right front of an Allis Chalmers tractor and when

Fig. 41.—Thomson Loader forming a bundle by pushing with the grab open, Louisiana.

lowered directly in front of the tractor the lower jaw of the grab lies flat along the ground. With the curved upper jaw open, the grab, pushed by the tractor, is thus able to push the cane forward until a sufficiently large bundle is formed (Fig. 41). The grab is then closed by the dropping of the upper jaw, and the boom raised (Fig. 42). Besides being mounted in the normal manner, the boom is also connected to the tractor frame by two radius rods. The method of connection of the rods to both boom and frame is such that as the boom is raised it is constrained to swing to the right, where the tripod action then supports the weight. The grab is then opened and the load dropped into the cane waggon (Fig. 43). In a model seen at the factory of the inventor, an hydraulic lift was being incorporated to operate the boom.

FIG. 42.—Thomson Loader, with bundle raised, Louisiana.

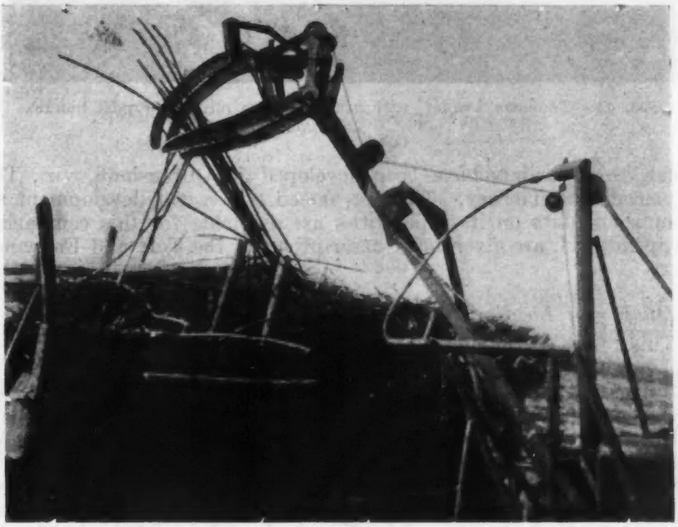

FIG. 43.—Thomson Loader, dropping bundle, Louisiana.

When the grab is on the ground one is reminded of an alligator, whilst when in the air its resemblance to the skeleton of a huge bird is striking (Fig. 44).

Operating results of this machine are not yet available, but, like the Barras, two men only would be required. It was stated that, complete with Allis-Chalmers tractor, the cost in America would be $2,500.

Comments on Mechanical Loading.

In comparing the mechanical loaders of Louisiana with those in Queensland, similar factors to those used for the cutting machine (with the exclusion of Method of Cane Delivery) must be considered. At

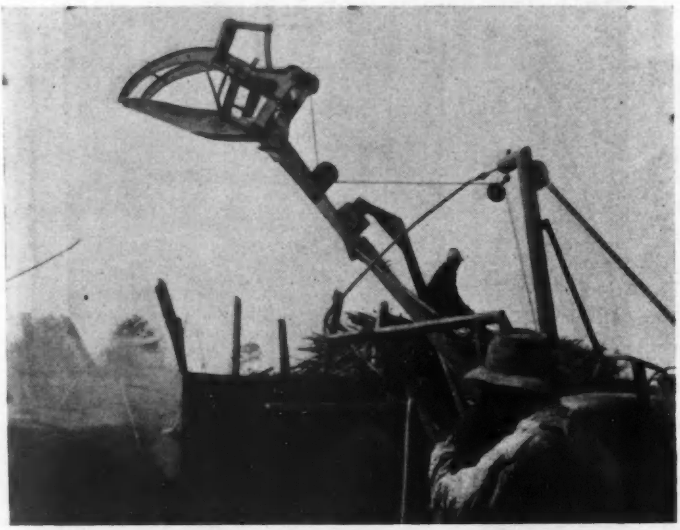

FIG. 44.—Thomson Loader, with grab about to return for next bundle, Louisiana.

present, three loaders have been developed in Queensland, viz., Toft, Fairymead, and Tierney. The last named is a recent development and not sufficient data on its capabilities are available for this comparison. In Appendix II. are given brief descriptions of the Toft and Fairymead loaders.

(i.) *Quality of Loading.*

This refers to the cleanness of the pick up and the neatness of the completed load. The former depends more on the cleanness of the original bundles than on the operation of the loader. The latter is also governed mainly by external factors, the chief of which are the type of transport used and the degree of neatness necessary. The Barras and Thomson are more restricted, however, and would not be expected to produce as neat a load. The last two machines, it must be remembered, are recent developments and have been made specifically to meet the requirements of the system of loading in Louisiana.

(ii.) *Speed of Loading.*

In this regard, as already intimated, the machines in Louisiana, when used under local conditions, load at a very high speed—up to 350 tons per day. The Queensland machines as operated normally do no more than 150 tons in the same time. The difference is due mainly to the system of loading and the highest rates are achieved with the Barras machine, which was made for the Louisiana system.

(iii.) *Versatility.*

Here the Queensland machines are definitely superior to those in Louisiana, in that they may pick up bundles over a wide radius and transfer them to any other point within this radius—indeed with the self propelled Fairymead loader the boundaries of the field alone set the limits to its sphere of operations. Naturally to obtain this wide sphere of operations loading speed has been sacrificed and the question immediately arises—do cane loaders need to be versatile?

(iv.) *Simplicity and Robustness.*

The Castagnos and Howard machines are simple to the point of crudeness whilst no great attention appears to have been paid to provide mechanical strength. The Barras and the Thomson appear to be well made mechanically and though eliminating much of the manual labour of the Castagnos and Howard are not unduly complicated.

The Queensland loaders have the added complication that the entire mechanism is mounted on a turntable. This calls for further complexity and introduces the problems of balance and rigidity. The Fairymead machine, which is self-propelled and mounted on caterpillars, is quite a complex machine.

(v.) *Cost.*

As with the mechanical harvesters, it is difficult to compare the costs of the machines in Louisiana with those in Queensland. The prices obtained, however, are listed below (the values for the American machines being converted to Australian currency at $3·27 per Australian pound):—

Machine.	*Price in Country Where Used.*
Castagnos	£370
Howard	£370 (estimated)
Barras	£1,990
Thomson	£800
Toft	£650
Fairymead	— (not determined)

The Castagnos is certainly the cheapest, but the large labour requirement largely offsets this. The Barras machine is expensive but the inventor states that when made in large numbers it would be expected to cost approximately £1,000. The Thomson machine, complete with tractor, appears reasonable at £800, but as yet its capabilities are rather indefinite.

The Queensland machines have the added complications referred to above. Hence it may be concluded that the prices are relatively more or less uniform.

(vi.) *Labour.*

In this connection the Barras and Thomson machines are outstanding, particularly when comparisons are made on the basis of the tonnage loaded. This is clearly shown in the following tabulation:—(No. data for the Thomson were available, but its performance would be expected to compare with that of the Barras.)

Machine.	Tons per Day.	Number of Men.*	Tons per Man Day.
Castagnos	250	6	42
Howard	250	6	42
Barras	350	1	350
Toft	130	3½†	37
Fairymead	150	3	50

* The driver of the cane cart is not included.

† Since the loader is drawn by the truck being loaded, it is assumed that one-half a man is required to drive the loader.

Summary.

In the foregoing comparison it is clear that the performances of the Louisiana loaders are greatly in advance of those of the Queensland machines. This is particularly so in the case of the Barras machine. The credit, however, does not lie entirely with the machines themselves, but is, in a considerable measure, attributable to the system under which they operate. This suggests immediately that the system rather than the machine might be introduced from Louisiana, but before this may be done its applicability under Queensland conditions must be carefully considered.

In summarising the comments on cane cutting machines it was stated that the question of application to Queensland was so important that a separate section would be devoted to it, and, since the loaders are equally concerned, the matter will be considered now.

Application of Mechanical Cutting and Loading in Queensland.

The sugar industry of Louisiana has amply shown that cane may be mechanically cut and loaded on a wide scale and at a high daily speed. Theoretically this may be done in Queensland also, but practically there are several serious obstacles. To illustrate the chief of these obstacles, let us assume that a Barras machine was brought to Queensland and that the cut cane was laid out in the Louisiana style to suit it. This machine is capable of loading up to 350 tons per day, but how many of the 8,000 Queensland growers could employ one effectively? Apart from the three or four large plantations, it is probable that the Barras machine could not be used effectively by a single grower.

The question may then be asked—"Could not the contract-system be introduced or some co-operative system be adopted, whereby one machine would be available to a group of farmers?" This is the obvious suggestion, but its application in Queensland is not very simple, for each grower desires to harvest his cane at the peak of maturity and would doubtless be averse to having his entire crop completely harvested

in a few days early or late in the season to satisfy the economic requirements of the machines. It is clearly absurd to have machines of high inherent capacity running round the district cutting or loading a few tons for this grower and a few for that in accordance with present allotments. Most of the time would be spent on the roads.

The problem is thus not one of the relative merits of the Queensland and Louisiana machines, but one of the possibility of the modification of Queensland methods to permit of the effective use of such machines. The growers in Louisiana were literally forced to do this, but in Queensland there is no such compelling circumstance, and the present system of payment for cane would need to be modified considerably before growers would be prepared to co-operate fully.

In concluding this section, the writer wishes to emphasise that he is definitely in favour of the development of mechanical harvesting since, if this method of harvesting were extensively adopted with the full co-operation of the growers, the saving to the industry would be tremendous, but before this may be achieved the social problem must be solved. This is a matter for the industry as a whole and till it is viewed from this aspect mechanical harvesting in Queensland will long remain the responsibility of a few enthusiasts, and the relative merits of this or that machine but secondary considerations.

Harvesting Methods in Hawaii.

For many years the Hawaiian sugar industry has been faced with a shortage of labour, particularly in the field. This has forced the managements to turn to mechanical methods of harvesting. The problem facing the industry was indeed formidable. Under local conditions, with two-year crops, a tangled mass of a hundred odd tons of cane per acre is the usual thing. Obviously, the type of cutter developed in Louisiana and Queensland would be completely inffective in cane of this sort.

The urgency of the problem forced rather drastic methods to be adopted, e.g. rake and grab harvesting. By these means the cane was literally dragged or plucked out *in toto* and then, with all other solid surface material, sent to the factory. This completely disorganised the milling work and necessitated the development and installation of cane cleaning plants at the factories. Much, however, has been written and said on the methods used, and the impact of this development, so there is no need to cover this ground in this report. Suffice it to give a brief account of the stage to which development has proceeded and to indicate the direction of future work.

The present method of harvesting is briefly as follows; first the cane is burnt. Here of course the success or otherwise of the burn will depend on the condition of the cane and the weather. In Hawaii, where everything left after the burn is taken to the factory, the importance of a good burn may well be appreciated. Indeed, as mentioned elsewhere in this report, the Experiment Station of the Hawaiian Sugar Planters' Association is experimenting with a weedicide in an attempt to kill the tops and so improve the quality of the subsequent burn. These tests have only been started, and though appearances are promising no definite results were reported.

After the burn, bulldozer or push rakes are then forced into the cane along the rows. These rakes (Figs. 45, 46 and 47) vary in type from field to field, but all consist essentially of a large rake twelve feet

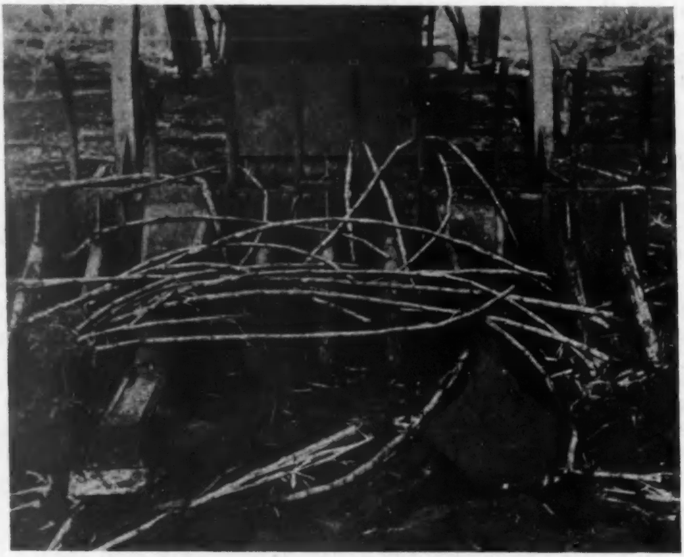

FIG. 45.—Typical push rake mounted on caterpillar tractor for harvesting cane in Hawaii.

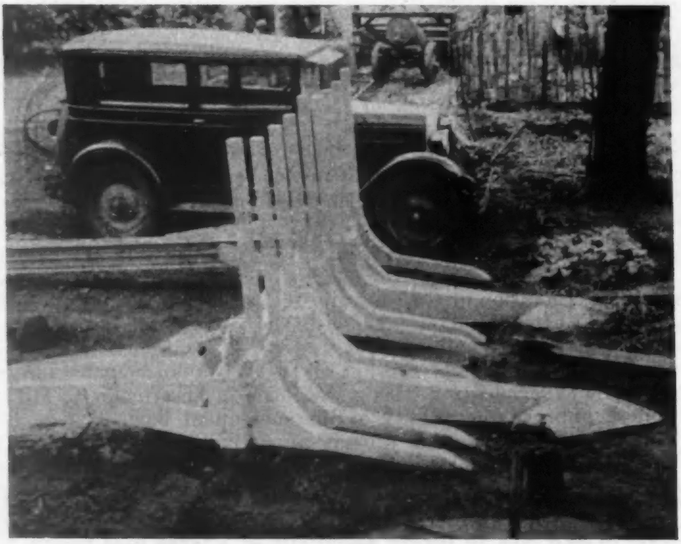

FIG. 46.—New push rake, prior to mounting, Hawaii.

long and four to six feet high, pushed by a caterpillar tractor. The rake is made of six to nine heavy tynes fastened to a heavy crossbar attached to the front of the tractor, which is protected by vertical rods attached to the crossbar. The entire rake is linked to the tractor by heavy side rods pivoted near the rear of the machine. When in operation, the tynes scrape along the ground, whilst for travel the rake may be lifted several feet. Generally two chisel shaped cutters extend beyond the front of the rake. These are six feet apart (the width of the interspace), and their function is to cut the stools as the rake is driven along the rows. The severed cane is then piled by the rake into a long heap, extending across the field. This pile comprises the cane with tops and any adhering trash, earth, stones, and any other foreign matter encountered by the rake (Fig. 48).

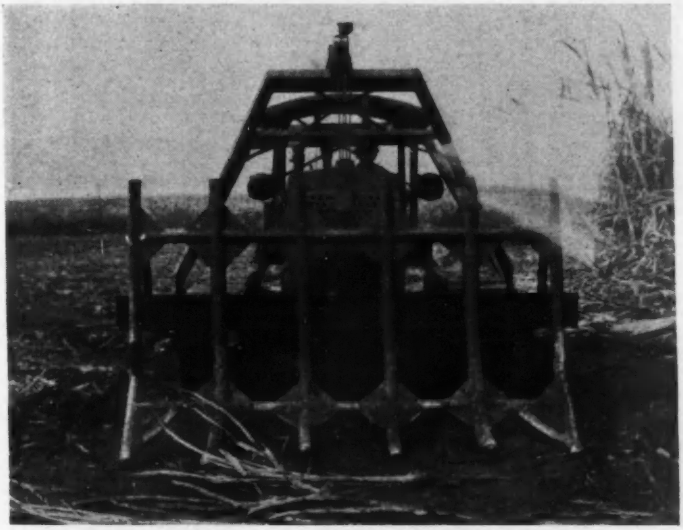

FIG. 47.—Smaller rake used for cleaning up during loading, Hawaii.

The next operation is the transfer of these piles to trucks for transport to the factory. Both tramway and motor haulage are used, whilst in certain cases fluming (particularly on the island of Hawaii) is employed. For the loading of trucks North-west grabs are in general use (Fig. 49). These consist of self-propelled swivelling jib cranes mounted on caterpillar tractors and the grab attached is capable of lifting 1 to 1½ tons. The cost of these grabs was given as $13,000 and the push rakes as $6,000. Each grab will load up to 250 tons per day, and a common "gang" comprises one push rake and two grabs and about 14 men (Fig. 50). Tramway trucks (Fig. 51) carry about three tons and the large motor trucks (Fig. 52) 8 to 10 tons.

A feature which renders mechanical harvesting more difficult on those plantations where irrigation is practised is the practice of growing the cane along the bottom of the irrigation ditches; indeed the requirements for this method of irrigation and for mechanical harvesting are

FIG. 48.—"Windrow" or pile of cane formed by push rake, Hawaii.

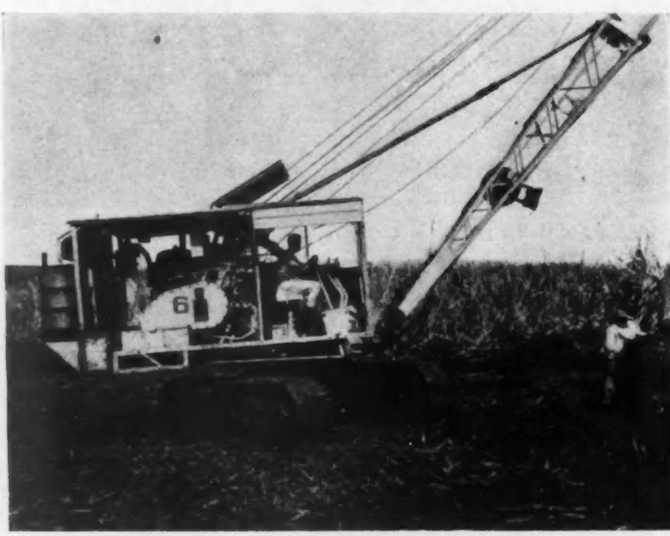

Fig. 49.—North-west grab for loading cane in Hawaii.

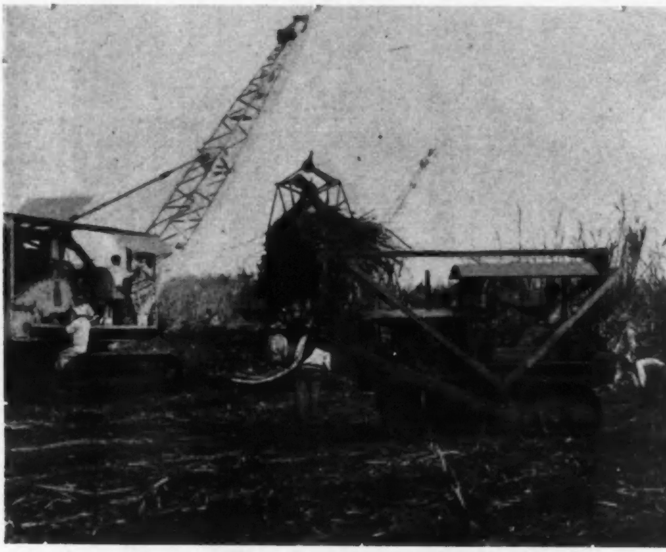

Fig. 50.—Typical loading gang in Hawaii, comprising two grabs and a push rake.

FIG. 51.—Loaded tramway trucks, Hawaii.

FIG. 52.—Loaded motor truck, Hawaii.

diametrically opposed, whilst the cost of reforming ditches after harvesting adds considerably to the cost. Where tramway haulage is used under these conditions, a tractor with a triangular shaped scraper resembling somewhat a gigantic flat iron (Fig. 53) is driven across the field to form a level base for the portable line. These scrapers are also used to provide tracks across the field for motor transport.

For laying portable line, track laying machines (Fig. 54) are being developed. These comprise a short jib mounted at the rear of a caterpillar tractor and the length of line is lifted by a rectangular device with small pivoted catches which grip the rails (Fig. 55). The use of this equipment does not appear to have reduced the number of field hands, however, and from this aspect its cost is hardly warranted.

FIG. 53.—Scraper attachment to tractor for levelling field prior to laying portable track, Hawaii.

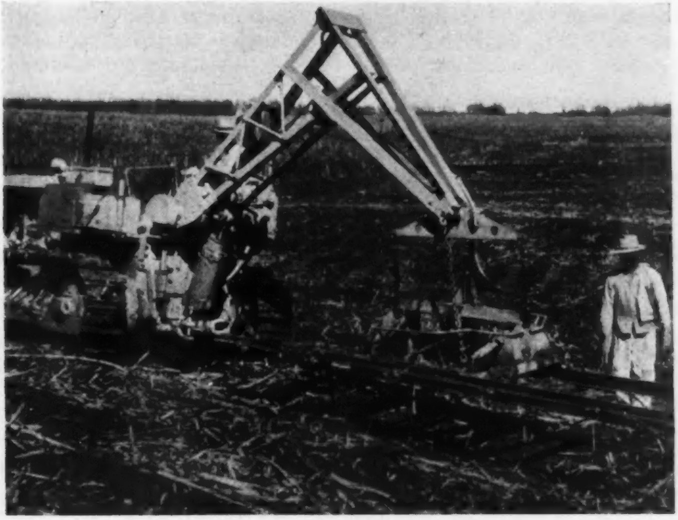

FIG. 54.—Portable track laying machine, Hawaii.

In areas where mechanically harvested cane is flumed to the factory, the cane is fed to the flume by means of a fluming machine (Fig. 56). This consists simply of an inclined cane table and a carding roll. A grab deposits a bundle of tangled cane on to the lower end of the table, the conveyor chains of which carry it to the upper edge, where the carding roll—a roller with long projecting arms—teases the cane off and drops it into the flume running past.

FIG. 55.—Rail gripping device on track laying machine in Fig. 54.

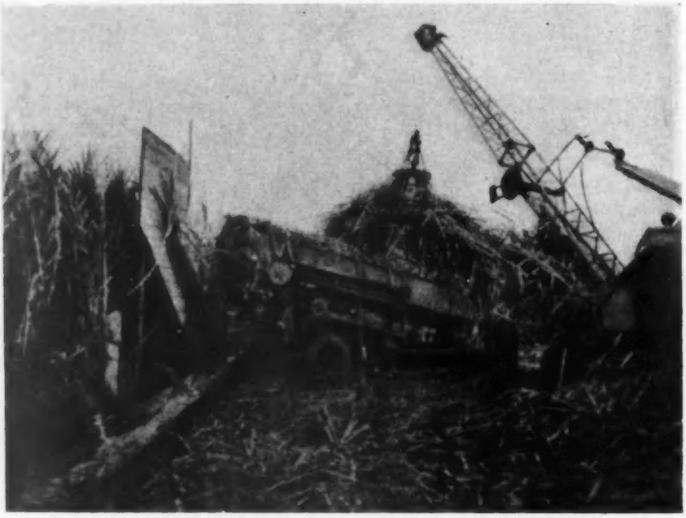

FIG. 56.—Flume loading machine in operation, Hawaii.

FIG. 57.—The Guild Harvester, Hawaii.

Discussions with plantation managers revealed that these methods of harvesting had little to commend them, and certainly would not be countenanced for a moment did not labour shortages make them the only practicable ones yet devised. Compared with hand cutting these methods do not appear to be cheaper because they cause considerable disorganisation at the factory, necessitating expensive installations and entailing excessive maintenance costs, whilst up to ten per cent. of the sugar in the cane is lost through the mangling of the sticks and extra factory losses.

In such circumstances, it is not surprising that the technicians of the industry are vigorously exploring every possible alternative. At the moment the most promising device is the Guild Harvester (Fig. 57). This is a 17 ton monster consisting of a sloping table mounted on caterpillar treads. Mounted above this table is a rake conveyor, whilst at the bottom are heavy rotating blades. It is forced into the cane, and the severed stalks are carried up the table and dropped over the rear. Mandrel shears at the sides cut the swathe free from the adjacent standing cane. The machine is still experimental, although over a quarter of a million dollars have been spent on it. Nevertheless, it is considered to offer distinct possibilities, and its development is being followed very closely.

Whilst the story of mechanical harvesting in Hawaii is intensely interesting, little or nothing of the present methods may be applied to the Queensland industry. In fact the hope may be expressed that we in Queensland may never be forced to adopt such extreme methods in order to keep our industry functioning.

The Influence of Extraneous Matter on Factory Operation.

It is generally accepted that at the present stage of development mechanical cane harvesters deliver cane in a considerably dirtier condition than do cane cutters in normal times. Distinction is drawn here between the two operations, cutting and loading, since it is considered that mechanical loading itself does not necessarily introduce additional extraneous matter. The introduction of this additional extraneous matter into the raw sugar factory will add to the difficulties of manufacture and this aspect of the problem must also be considered closely. There are two obvious solutions: (1) to permit a reasonable quantity of additional extraneous matter to enter the factory and to modify the process to accommodate it; and (2) to perfect the harvesting, so that a high standard of cleanliness is achieved in the cane delivered to the mill.

In seeking a solution, the problem must be attacked from the broad industry viewpoint. At present each section of the industry is concerned more with its own interests without much regard for those of the other section. For example, millers demand clean cane, but the cost to the grower of producing the required standard of cleanliness may be greater than the loss to the miller in treating the dirty cane at slightly lower efficiency. On the other hand, the reverse might equally be true. If then, mechanical cane cutting is to become at all widely used in the Queensland industry and its use introduces excessive extraneous matter, then it is imperative that both sides collaborate and determine a general policy which will furnish the maximum benefits to the industry as a whole.

The problem is an exceedingly difficult one and it seems that a vast quantity of carefully determined data must be accumulated before any hope of a useful solution is possible. That there is a manufacturing loss due to the influence of extraneous matter is plausible to assume, but what the magnitude of this loss would be and whether the miller would be partially, completely, or over-compensated as the result of the reduction in C.C.S. consequent on the lowering of juice purity, are questions which may only be answered by direct experimentation in Queensland.

The delegation made enquiries in Louisiana and Hawaii as to the influence of extraneous matter on factory performance. In the former country little information was available, although many opinions (obviously biased) were expressed. Professor Keller of the Louisiana State University advised that in 1944 several tests had been conducted at the experimental factory in an attempt to evaluate the influence of trash. The results of these tests were reported in the Sugar Bulletin, 15th June, 1945. The quantity of trash varied from 10·39 to 12·15 per cent. and in each case a parallel trial with clean cane from the same source was made. The following general results were noted:—

(i.) The crushing rate was reduced by 12–16 per cent.

(ii.) The influence on extraction was indefinite.

(iii.) The purities of crusher and mixed juices were appreciably lowered.

(iv.) The sugar recoverable per ton of cane (calculated by the Winter-Carp formula) was greatly reduced.

(v.) The quantity of molasses per ton of cane was increased.

(vi.) The total monetary value of recoverable sugar and molasses was reduced.

The variations from test to test were so great that quantitative evaluation of the above points was impossible. A far greater number of tests would be required to enable this to be attempted.

In Hawaii, it was stated that the drastic method of harvesting there caused a loss of sugar up to ten per cent. of that of the original cane. This loss, of course, is not all due to increased difficulties of manufacture, and is made up as follows:—

5 per cent. due to crushing and mangling of sticks in the harvesting process;

2 per cent. due to the washing out of the juice from the broken sticks by the water sprays of the cane laundry;

3 per cent. due to extra factory losses, i.e. lower extraction, and higher mud and molasses losses.

Hawaii, of course, represents the extreme case, the quantity of extraneous matter varying from 12–30 per cent. On the other hand, the sugar factories in Louisiana have no cane cleaning laundries, and in wet weather, when it is impossible to burn the trash, the cane is received at the factory in an exceedingly dirty condition. Professor Keller mentioned that since mechanical harvesting had become widely adopted in Louisiana, the factories had found it necessary to install extra settling capacity to cope with the extra mud (mostly soil) brought in with the cane.

Apart from the reduction in recovery of sucrose other sources of loss are encountered. In Hawaii a roller shell lasts two seasons only, due to the excessive abrasion of soil particles. In one factory visited the grooves were completely worn off the top rollers after ten months' use.

The laundries in use in Hawaii are also expensive to operate, and do not remove more than 70 per cent. of the extraneous matter. Not the least cost is the pumping of three to seven million gallons of water per day. This is equivalent to 2,000 gallons per ton of cane. No cost data, however, could be obtained to indicate the extent of the extra costs of manufacture under these conditions, since in Hawaii, where the plantation and the factory are owned by the one company, costs of production and manufacture are not always separated.

The value of the influence of the remaining extraneous matter on factory performance (three per cent. of the sugar in the original cane) is given as the result of experience over the years. Other factors have operated during this period, e.g., the varieties grown have changed markedly, consequently, this value must be taken as an indication only. Obviously, it is not possible to assume that, were such methods of harvesting adopted in Queensland, a similar loss would result. As already mentioned, direct experimentation over a protracted period is required, and these experiments should be on a scale sufficiently small to permit of adequate control, but large enough to represent actual working conditions. This could only be carried out with an experimental mill, and, until our industry has such a unit, this and similar problems must remain unsolved.

AGRICULTURAL IMPLEMENTS.

In that section of this report dealing with the agricultural practices in Louisiana and Hawaii, it will be recalled that it was emphasised that in both cases these differ markedly from those employed in the Queensland cane fields. In contrast to common practice in Queensland, growers in Louisiana hill the land into 18-inch ridges six feet apart, and then plant the cane at an average depth of six inches at the top of these ridges. In Hawaii the reverse is the case in the irrigated areas, viz., the cane is grown along the bottom of deep irrigation trenches. The latter practice is followed in irrigated districts of Queensland. but these of course represent only a small part of the Queensland cane areas. Naturally different methods of cultivation in many cases call for special implements, many of which are unlikely to have immediate application under Queensland conditions. Moreover, under the plantation system in Hawaii large heavy units are generally used and these, in any case, would be impracticable for the average Queensland grower.

When at Chicago the delegation visited the International Harvester Company. Here discussions around farming equipment were had and films illustrating new equipment were seen. In past years this Company maintained an implement showroom,, but during the war years, from lack of space, this had to be discontinued. Consequently, it was not possible to see a selection of implements for cane cultivation. A visit was paid to the tractor factory of this Company.

There were, however, in general use several implements which it is felt might be of interest to Queensland cane farmers.

Implement for Ploughing out Stools.

This implement (Fig. 58) is used extensively in Louisiana, and was referred to by Mr. N. J. King in his report to the Queensland Society of Sugar Cane Technologists, 1939. It consists of a heavy rectangular frame with a straight coulter at the front. Behind this is a double mouldboard plough or middle buster—the implement itself is frequently referred to as a middle buster. At the rear are two gangs of scalloped discs, one on each side of the middle buster. As this implement is drawn along a row of stubble behind a tractor, the straight coulter splits the stool, which is then rooted out by the middle buster, half to each side, into the paths of the two gangs of scalloped discs.

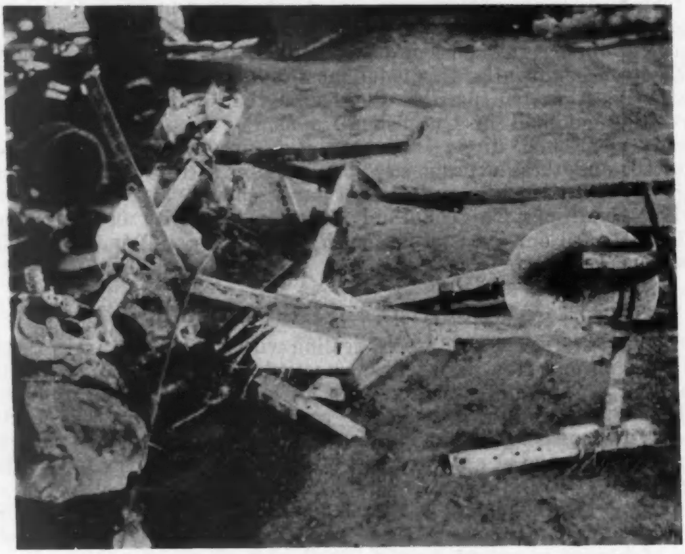

FIG. 58.—Implement used in Louisiana for ploughing out stools.

The operation of this implement was later discussed with the executives of the International Harvester Company in Chicago, who agreed to the suggestion that such an implement be brought to Queensland for trial purposes. Some modifications may be necessary for Queensland conditions, when the ratoon fields are reasonably level before plough-out, since the middle buster would then leave a furrow along the line of the cane row.

Manure Spreader.

At Albania Delgado, in Louisiana, a new International Harvester Manure Spreader was inspected and later, in Chicago, a film showing the machine in operation was seen at the headquarters of the Harvester Company.

The implement consists of a two-wheeled pneumatically shod cart drawn by a tractor. Operated by chains from the axle of the cart is a conveyor delivering towards the rear of the cart, where a scroll-type spinner is mounted. The cart is loaded with farmyard manure and then taken to the field. Here, by moving a lever, the chain drive is connected to the sprocket on the axle so that when the cart is moved forward the conveyor operates and carries the manure to the distributor, which is said to fling it a distance of 18 feet to either side. Such a machine might find application in handling filter cake and for spreading lime.

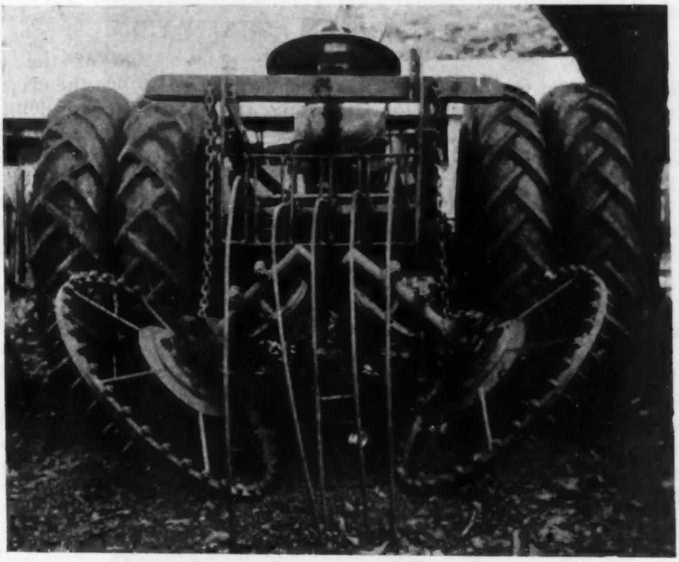

FIG. 59.—Disc Weeder used in Hawaii.

Disc Weeder.

This implement, which is a tractor attachment, was seen in Hawaii, where, it is gathered, it was developed from the Churchill irrigation-furrow reshaper. It is now referred to as the Ford Disc Weeder. It consists of two toothed discs drawn behind a tractor. The axes of the discs are in the same vertical plane, but are inclined towards each other at the top. This angle is adjustable so that the slope of the discs may be varied to suit the sides of the furrows down which they are drawn. The discs rotate by friction on the ground and the teeth acting in the manner of a cultivator remove the weeds. A typical construction is as follows:—

The discs, which are 36 inches in diameter, are made of ½-inch plate and are dished about 1½ inches. A ½-inch by 1-inch circular reinforcing plate is welded in the centre of the disc and to this plate is welded a piece of 2½-inch heavy pipe 18 inches long. This pipe serves as a standard, and, by passing it through a bushing on the tool bar bracket, it also acts as a journal for the disc. Adjustable collars are placed above and below the bushing so that the discs may be regulated for height.

The cutting rim on the disc is made from ¼-inch by 4-inch spring steel. Some rims are notched, some are used plain, and some have a row of 3-inch long harrow teeth around the edge at about 3-inch intervals. The type of disc used depends on the amount of—and type of—grass that is to be removed.

In another type seen at the Oahu Plantation the solid disc is replaced by a six-armed spider (Fig. 59).

One man driving the tractor is reported to be able to cultivate from 4·5 to 6 acres per day.

FLAME AND SPRAY CULTIVATION.

The elimination of weeds from canefields is one of the chief problems confronting the farmer and has been so ever since the crop was systematically cultivated. Hand chipping or hoeing was for long the only method and, as long as cheap labour was available, was eminently satisfactory. Mechanical methods have now been introduced, but these do not completely control weeds in or near the cane row, and few farmers are able to carry on without occasional chipping. Moreover, recent investigations have indicated that repeated mechanical disturbance of the soil causes a breakdown in soil structure, depletes fertility, and damages the root system of the cane.

In those countries where labour costs are high, it is natural that efforts have not been spared to develop other methods of weed control and the two most promising so far are: (1) the use of flame to burn the weeds, and (2) the use of weedicides to kill the weeds. The former has been used on quite a large scale in U.S.A., particularly in the cotton areas, whilst its application to sugar fields is said to be spreading rapidly. The poisoning method has been used in the cane areas of Hawaii for many years, whilst at present a new type (or rather a modification of an old type of poison) is being tested extensively.

Flame Cultivation.

This is also described as selective burning, since the procedure is to apply a hot flame along the entire row of plants when the weeds are small and to rely on the greater resistance of the cane (in the case of canefields) to the scorching effect.

Several types of apparatus and fuel are used and a number of reports have been prepared by Dr. Barr, of the Louisiana State University, on their operation.

The flame cultivator is used to destroy young weeds in the row of cane from the time the cane is 9 inches above the ground until it is 3 to 4 feet high. In the case of Johnson grass (*Sorghum halepense*) results have been variable—some tests having been successful and others doubtful. It is believed, however, that improvements in technique may result in effective control of this grass.

There are two main types of cultivator in use: (*a*) the sulky type (Fig. 60) and (*b*) the tractor type. The same principles are employed in both, but in the latter type the entire equipment is mounted on the tractor and operated from the power take-off. The sulky type is the more common and consists of a two-wheeled vehicle carrying a reservoir of fuel, compressor and burners. For keeping the burners correctly placed over the row a skid arrangement is provided. Two burners

operating on the Bunsen principle are provided and are attached near the ground facing each other. They are mounted flexibly and adjusted so that the flames do not meet, since this would cause considerable upscorch.

The machine is of very simple construction and similar ones could be built in Queensland at a very low cost.

Fig. 60.—Sulky type of flame weeder used in Louisiana.

At a later date the delegation visited the Fijelan Research and Development Co., Washington, D.C., which Company holds the U.S. patent rights for the "Sizz Weeder." The managing director of this Company stated that 500 machines were operating in the United States, of which 200 were in the sugar cane areas of Louisiana, the remainder being mostly in cotton.

The acreage handled naturally varies with the kind, thickness, and growth of the weeds to be treated. A single-row machine would handle from 40 to 100 acres per week; the usual practice is to cover each field once per week. This principle is also used to some extent in Louisiana for keeping permanent railway lines free of weeds. In this case the burners are mounted on a small truck drawn behind a locomotive.

Spray Cultivation.

The killing of weeds by poisons is not a new idea. For many years arsenical sprays have been used, but these have certain drawbacks, although it may be mentioned that opinions regarding these are somewhat controversial. It is claimed in some quarters that the constant application of arsenic to the soil results eventually in an accumulation of this element which may be detrimental to root development, and so reduce production, particularly in light textured soils. Others point out that the concentration of arsenic to produce this effect in the soil is never likely to be reached with the rates of application normally employed. The hazards of handling this material have also received their share of over- and under-statement. Admittedly the use of arsenic is not to be preferred if some other "non-poisonous" but equally efficacious weedicide can be developed.

To this end the Experiment Station of the Hawaiian Sugar Planters' Association has been experimenting with diesel oil emulsions, since diesel oil is a well-known weedicide. Numerous mixtures have been made and tested and at present what is known as "Cade 24" has proved the most promising. This is a mixture of diesel oil, water, an activator and a spreader or wetting agent. A concentrated emulsion is first prepared using diesel oil and water in the proportion of two to one. Incorporated in this concentrate are the wetting agent and part of the activator. If all the activator were added here it would break the emulsion. Magnesium in the water has the same detrimental effect so that magnesium-free water is essential. Fairly high concentrations of sodium chloride may be tolerated.

This emulsion must be absolutely stable so that special care must be given to its preparation. Any of the standard types of equipment may be used for this purpose, but that selected by the Experiment Station of the H.S.P.A. is a high pressure pump which circulates the oil and water mixture through a small orifice under very high pressure (2,500 lb. per sq. inch). A high speed agitator or disc colloid mill may also be used, but all are expensive pieces of equipment and capacities are low.

Before application, this concentrate ("Cade") is diluted with water containing the remainder of the activator, the degree of dilution varying from 1 to 10 to 1 to 40, depending on the size of the weeds to be treated. The diluted mixture is then sprayed on to the weeds by any of the usual types of spray. It was stated that for weeds one inch high the higher dilution was satisfactory, and about 175 gallons per acre in each of two applications was sufficient to give a complete kill.

With a tractor drawn tank with pump and hose attachments and operated by three men, three acres per day may be sprayed.

No cost data were available, but a request for complete information was made to the Director of the Experiment Station, since this development may prove of considerable value to certain areas of Queensland, e.g., the heavy rainfall areas, and the irrigated areas, where it is undesirable to interfere with the expensive irrigation set ups by cultivation. Naturally it will be necessary for well conducted trials to be performed here before the value of this weedicide may be generally assessed.

It is interesting to report that tests have been started to determine whether this weedicide may be effective in killing cane before the preharvest burn in order to improve the effectiveness of the burn. No results have yet been obtained but it was stated that from the appearance of the trash on treated cane some improvement was anticipated.

NEW VARIETIES.

In Washington arrangements were made with Dr. Brandes, of the United States Department of Agriculture, for the despatch to Queensland of five Canal Point. Florida, varieties which have shown promise in Louisiana. It will be recalled that C.P. 29-116, which is now attracting a lot of attention in South Queensland, was brought from America some years ago. This variety is grown widely in Louisiana, but some of the new ones are expected to prove better there. Naturally the resistance of these canes has been tested against only those diseases which occur in Louisiana, and they will have to go through appropriate resistance trials in Queensland before propagation is undertaken. Two of the selected canes have proved rather poor ratooners in Louisiana, but winter conditions there are so severe that it was considered they should not be rejected on that account when considering introduction into Queensland. The varieties chosen are:—

(1) C.P. 34-120.—Widely planted in Louisiana, liable to lodge, ratoons well, good sugar, high fibre, immune to mosaic, very resistant to root rot, moderately susceptible to red rot.

(2) C.P. 29-320.—Matures early (probably the earliest maturing variety grown in Louisiana), high sugar, high fibre, erect growth, immune to mosaic, resistant to root rot, moderately resistant to red rot, found to be very susceptible to leaf-scald in Brazil.

(3) C.P. 36-105.—Upright growth, high fibre, immune to mosaic, resistant to red rot and root rot, susceptible to brown spot.

(4) C.P. 34-79.—High sugar, poor ratooner, very susceptible to red rot.

(5) C.P. 36-62.—High sugar, poor ratooner.

These canes are expected to arrive in Queensland during May this year.

In regard to the cold-resistant Turkestan hybrids, Dr. Brandes stated that to date no promising canes had been obtained by back crossing to commercial canes. (The original Turkestan canes remain green in the midst of snow, and crosses from this line should carry a high degree of frost resistance.)

[N.B.: The remainder of the report, which deals mainly with Milling Practices and Equipment, is reproduced in full in News Letter No. 14. A brief summary only is included here.]

MILLING PRACTICES AND EQUIPMENT.

The most outstanding features noted in the factories visited were—
(1) The effectiveness of the combination of the crusher and Searby shredder in providing preparation. This was observed in several Hawaiian mills. Unfortunately the existing system of payment for cane precludes the use of the crusher in Queensland.

(2) The high degree of exhaustion of the final molasses in Hawaii. The results obtained in Hawaii are most outstanding, and it would seem that Queensland factories, particularly in North Queensland, could well give consideration to the application, in part at least, of the methods and equipment used in Hawaii.

(3) The general adoption of high speed centrifugals for low grade massecuite treatment. This is particularly the case in Hawaii, where large batteries of Roberts machines have been installed. The high gravity effect of these machines has been an important contributing factor to the success obtained by the Hawaiians in achieving the degree of exhaustion referred to in (2).

BULK HANDLING OF RAW SUGAR.

The handling and storage of raw sugar in bulk was examined very closely in Cuba, United States and Hawaii. In Hawaii, on the island of Maui, all sugar is stored in bulk at the port and thence shipped in bulk to the mainland for refining. A general view of the waterside storage facilities at Maui is shown in Fig. 61. The sugar is carried to

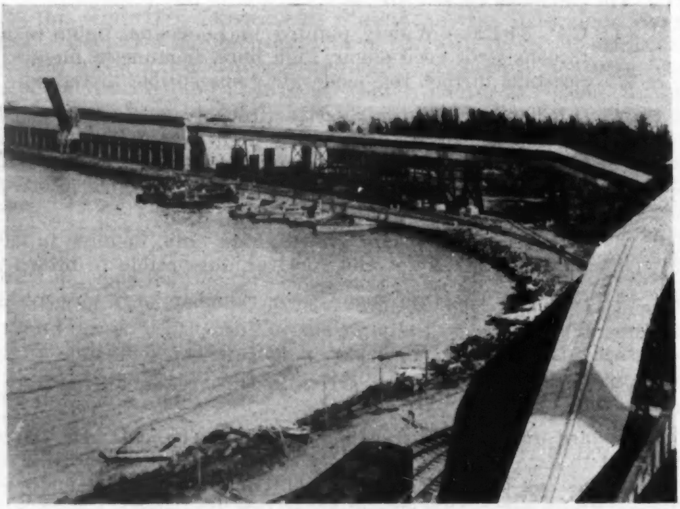

FIG. 61.—Bulk Sugar Storage, Kahului, Maui, Hawaii.

the port in large boxes on motor trailers or railway wagons. It is then tipped into a hopper and conveyed by belts to the storage bins. When a vessel is being loaded the sugar is dropped through openings at the bottom of the bins into further conveyor belts and so transferred to the vessel in a continuous stream. In this way eleven men can load at the rate of 400 tons per hour. The saving in labour, complemented by the elimination of bags, makes this method of handling considerably cheaper than was the case when the sugar was bagged.

LIQUID SUGAR.

In New York, a considerable proportion of the output of one refinery was in the form of a pure concentrated sugar solution. This solution was delivered to consumers in tank cars and trucks, and, where large quantities of sugar were used, storage and the manufacturing process were both greatly simplified.

TECHNICAL RESEARCH.

Discussions with members of the Sugar Research Foundation at New York and with Prof. A. G. Keller, who directs the Audubon Experimental Sugar Factory at Baton Rouge, indicate the necessity of furthering research in the sugar industry of Queensland. The establishment of an experimental factory here is most desirable, and it has been recommended that when conditions permit a suitable installation be made.

SUMMARY AND CONCLUSIONS.

In such a report it is not easy to summarise the various matters discussed. There are, however, certain points which need condensing to give due emphasis. This may best be done in a summary.

Mechanical Harvesting of Cane.

The opinions of the writer on this subject are as follows:—

(1) The mechanical harvesting machines of Queensland are at least as good as those of Louisiana.

(2) The mechanical loaders of Louisiana, when operated under their system, are far superior to those of Queensland.

(3) The present systems of the harvesting of, and payment for, cane in Queensland virtually prohibit the use of mechanical harvesting methods on a wide scale.

The conclusion that may be drawn from this is that before mechanical harvesting equipment may be developed in Queensland, the first logical step is for the industry to examine the position from all angles and to determine whether the advantages of mechanical harvesting would warrant the radical changes necessary in the present harvesting system in order to accommodate mechanical methods. For this purpose an Industry Committee should be formed, representing all parties concerned.

Agricultural Implements.

Several types of implements are described which might prove useful to Queensland growers. It is suggested that arrangements be made for the introduction of these for general trial in Queensland.

Flame and Spray Cultivation.

The methods of cultivation by flame and spray as used in Louisiana and Hawaii respectively are described. Inasmuch as the success of such methods generally depends on economic features and the costs of one country do not as a rule bear any great relationship with those of another country, it is recommended that experiments within the Bureau be conducted to determine the efficacy of these methods.

New Varieties.

Arrangements were made with Dr. Brandes for the introduction of five new and promising C.P. varieties of cane.

Milling Practices and Equipment.

The value of the combination of the crusher and Searby shredder for obtaining preparation is indicated. However, as with mechanical harvesting, the present system of cane payment prohibits the use of the crusher in Queensland.

The possibility of the advantages of long maceration carriers being over-stressed in Queensland is deducted from the excellent milling performances of short trains in other countries.

The marked trend toward the adoption of high speed centrifugals is reported and the possibilities of adopting (in part at least) the low-grade massecuite treatment methods of Hawaii are shown.

Bulk Handling of Sugar.

The advantages of handling sugar in bulk over the ordinary method, whereby the sugar is bagged, are described. The successful adoption of this method of handling in Hawaii, Cuba and U.S.A. suggests that the Queensland industry could well give consideration to it.

Liquid Sugar.

Concentrated pure sugar solution is finding wide use in the metropolitan area of New York due to its great convenience. It is suggested that its use in Australian capital cities might be advantageous.

Technical Research.

The work of the Sugar Research Foundation Inc. is briefly mentioned.

Reference is made to the shortcomings of the experimental sugar factory at Audubon, Louisiana, and the means of overcoming these are discussed. It is recommended that as soon as conditions permit an experimental factory be provided in Queensland.

General.

A feature which rises frequently in this report is the subservience of technical methods to matters of policy in regard to harvesting and payment for cane in Queensland. Under the present system, mechanical harvesting on a wide scale is impossible; the use of crushers (standard equipment in all other countries) is prevented, and although not dealt with in this report, the use of a control system based on weights of products offers little advantage to the miller.

The restrictions placed on the technical development of the industry by the harvesting and payment systems should be examined very closely, as it is not inconceivable that in saving pence they are losing pounds.

ACKNOWLEDGEMENTS.

In conclusion, the writer wishes to record his appreciation of the assistance given by the many people encountered in the countries visited. At all times they were ready to provide whatever information or assistance that was requested. Whilst their number is too great to list them, special reference must be made to Dr. W. E. Taggart, and Dr. I. L. Forbes, of the Louisiana State University; Mr. W. E. Dickinson, of Cuba; Dr. F W. Zerban, of the Sugar Trade Laboratory of New York; Dr. H. L. Lyon and Mr. E. J. Stirninan, of the Hawaiian Sugar Planters' Association, Honolulu; and Mr. W. Walsh, of the Kahului Railroad Company, Maui. These gentlemen were almost overwhelming in the courtesies they extended.

The writer specially desires to record his sincere appreciation of the valuable discussions with Messrs. Muir and Toft, and the general assistance they rendered throughout the trip.

Finally, to the Sugar Experiment Stations Advisory Board for recommending the trip, and to the Queensland Government for providing the facilities, the writer is duly indebted.

Fig. 62.—Toft cane harvester, front view, showing cutting, gathering, and elevating devices.

APPENDIX I.

DESCRIPTION OF QUEENSLAND CANE HARVESTING MACHINES.

The Toft Cane Harvester.

This is a self-propelled, cutting and topping unit (Figs. 62–64). It is mounted on three wheels, two at the rear and one at the front. The front wheel is set to the left of the centre, and provides the means of steering from a hand-wheel on the driving platform, immediately above. The unit is about 14 feet long, plus approximately four feet extension to carry the topping mechanism, and about nine feet wide to enable it to operate after only one row of cane is cut out. The rear wheels are independently braked, thus facilitating turning. The cutting mechanism is carried by an arm extending from the frame work to the right front, and supported on a castor wheel. The complete operation provides for cutting, elevating, topping, and tipping in bundles.

Cutting.

The cutting mechanism consists of two overlapping rotating coulter discs, one of which is 24 inches and the other 30 inches diameter. The larger diameter is necessary to provide for cutting before the sticks are engaged by the fingers of the elevating chain. The discs are tilted inwards and set up at the rear and are driven by bevel gears from shafts, chain driven at the motor end. The periphery of the smaller disc travels 7 inches per 1 inch of forward movement of the machine. The discs are mounted on separate arms tied together below the elevating ramp, and pivoted to the frame work of the machine, and may be adjusted in height by means of a screw attached to the arm carrying the castor wheel. A second adjustment is provided by means of a lever with quadrant and pawl on the driving platform. The adjustments for raising and lowering the discs are by means of wire rope and heavy coil springs. All the cutting mechanism can be driven independently of the tractive drive.

FIG. 63.—Toft cane harvester, right side view.

Elevating.

Immediately the cane is cut by the discs the sticks are engaged by fingers attached to two endless chains, one at the bottom and on the cane side of the machine, and the other about 3 feet above and on the opposite side. These chains drag the sticks in an upright position up a ramp towards the rear of the machine at an elevation of about 25 deg., and between guide arms spaced about 9 inches apart. A third chain on the cane side of the ramp at the same height as the top chain feeds the cane into the guides. At the top of the ramp a fixed plate deflects the bottoms of the sticks to the left and disengages them from the fingers. This immediately arrests the backward motion of the bottom of the stick, while the top chain carries the top of the stick a further two feet, thus causing the sticks when disengaged by the top chain to fall with the tops to the rear on to a platform inclined at about 20 deg. All chains are of similar pattern—roller type—and are operated from shafts at the top. Loose sprockets and bearers keep the chains accurately in position. The cane is now in position to be prepared for topping.

Topping.

The recumbent cane with tops rearward is now carried laterally up the inclined platform by means of chains with fingers attached. Guide bars are provided above the platform to preserve a single layer of sticks on the platform. The topping mechanism, which consists of a disc rotating clock-wise from the rear, is carried on a section mounted on ball bearing slides to permit of adjustment for the length of the stick. As the sticks are carried across the platform the position of the tops for cutting is determined by what may be described as a beater. This beater consists of a heavy rubber belt 12 inches wide mounted normal to the plane of the platform and diagonally across the back end of the platform and fitted with a number of flat iron paddles extending 9 inches from the belt. The belt is driven in the direction of the lateral movement of the cane by a friction roller and the paddles beating against the tops of the cane force the sticks into a uniform position for topping.

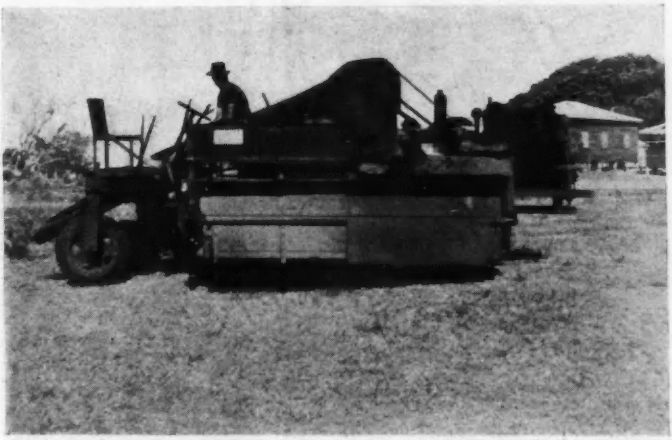

FIG. 64.—Toft cane harvester, left side view showing bundle tipping arrangement.

The entire beater mechanism may be pivoted about the friction roller to allow for different lengths of tops. Arrowed cane can be dealt with in a similar manner. The effect of the arrow is merely to elongate the top. By lengthening the extension which carries the topping mechanism, the arrows are dealt with as an extra long top. At this stage the sticks contact the cutting disc and the paddles discharge the tops on to the ground, the sticks themselves falling into the pivoted box running the full length beneath the platform.

Tipping.

The box which collects the topped sticks consists of two compartments and is rotatable longitudinally. It is so designed that when one bundle is being tipped the movement is arrested half-way to allow of the bundle being cleared by the mechanism before the second compartment is turned fully into position. The tipping is controlled by a lever with ratchet and pawl on the driving platform.

The Fairymead Two-Row Cane Harvester.

This is a self-propelled cutting and topping unit (Figs. 65 and 66), operating simultaneously on two rows of cane. In contrast to the Toft machine, which is a unit designed primarily as a cane harvester, the Fairymead machine is built on to a wheel type Farmal Model MD tractor. It is necessary to adapt the tractor by arranging a jack shaft drive somewhere about the same height as the driver's seat. This jack shaft eliminates the differential and allows room for the hopper which receives

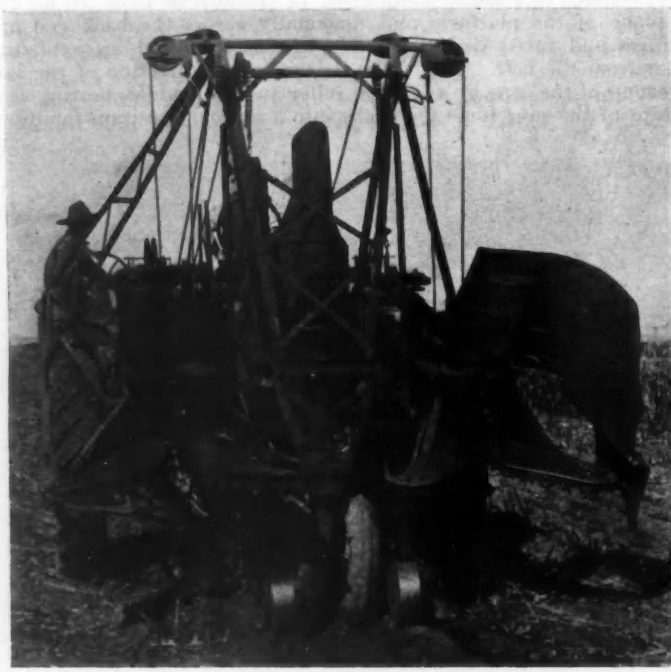

Fig. 65.—Fairymead two-row harvester, front view, showing gathering and topping devices. Baffle on front right hand side of machine has been removed.

the topped sticks of cane. The entire framework of the topping, cutting, and tipping devices increases the overall length of the tractor by about 50 per cent. Two men are required in the operation. The first man steers the machine and operates the topping and gathering apparatus by means of a clutch lever. The second man sits behind the hopper and operates a foot and hand lever which opens the bottom of the hopper; he also controls the height of the cutting device if it is necessary to raise it from the ground when turning.

For each row a separate gathering, cutting, topping, and conveying unit is provided. These are mounted, one on each side of the tractor, and deliver the cut and topped sticks to a common hopper at the rear.

The main frames which carry the gathering, topping, and cutting apparatus, one for each row, are hinged on to the tractor about half way between the driver's seat and the engine and are supported at this point and also at the front by wire ropes and sheaves. These ropes and sheaves provide means for raising and lowering the topping devices. The main frames are raised or lowered by these wire ropes and sheaves by means of a power drive and friction clutch. The main frame carries several short vertical shafts and idlers, on the lower end of which are chain wheels. Around these chain wheels run the conveyor chains to carry the topped and cut sticks up the conveyor.

Fig. 66.—Fairymead two-row harvester, showing cutting blade and gathering devices and bundle hopper between rear wheels.

Gathering Device.

The gathering apparatus right at the front of the machine is arranged with a wide spread so as to gather all stalks in the row of cane. It consists of two endless roller chains with plate fingers running inwardly towards each other. The gatherers, being built on the main frame, can be lowered or raised to gather in short or long cane by tilting the entire frame on its hinged joint by means of the power drive, ropes and sheaves previously mentioned. The gathered cane is delivered to the topping device before the bases of the sticks are cut. The drive for the gatherers is geared from the conveyor chains and is at the same speed.

Topping.

After the sticks are gathered they are gripped about one foot below the topping level by the conveyor chains. They then come in contact with the topping device. This consists of two circular discs revolving inwardly towards each other and overlapping slightly. One disc is fitted

with five short straight knives arranged radially. As the tops pass between the discs they are severed from the stick by these knives. Just above one of the topping discs is arranged a number of radial fingers which rotate on the same shaft as the second disc. These fingers gather the top after severing it and throw it away from the tractor towards the outside. Both the cutting discs and these radial fingers revolve at the same speed as the chain wheels which operate the gatherers and are driven therefrom. To avoid the thrown-away tops becoming mixed with bundles of cane already on the ground, vertical baffles are built on each side of the tractor. The severed tops hit these baffles and fall to the ground. The topping device is controlled manually through a clutch lever to raise or lower for tall and short cane and for irregularity in height of cane in the row. At the completion of topping the sticks are still uncut at the base.

Cutting.

The cutting device is a shear blade approximately four feet six inches long and eight inches wide set at 45 deg. to the longitudinal axis of the tractor. The blade is built up from a heavy steel plate to the edge of which is riveted a section of heavy saw steel. It is arranged on a tubular framework pivoted to the bearer of the tractor and has a small wheel just forward of the shear blade. This wheel controls the regularity of height of shear above ground. The blade can be raised for traversing by means of a hand wheel and worm drive at the driver's seat. The cane is therefore cut or sheared off by the forward movement of the tractor and then enters the conveyor system.

Conveying.

The conveyor chains run from front to rear of the tractor. The two chains are in contact with each other and one chain carries serrated teeth to grip the stick. These chains are at the same level as the gathering chains and are about one foot below the topping discs. The speed of the chains backward is the same as that of the tractor forward. The sticks are thus gripped by the conveyor chains before being cut at the base. They are conveyed backwards with slight backward lean until the lower end comes in contact with the bottom of the hopper. The top of the stick is still engaged by the conveyor chains which force the sticks to fall over, and when released by the chains fall into the hopper.

Hopper.

The hopper is placed between the rear wheels so that the front is midway between the topping apparatus and the rear of the tractor. It is a rectangular box with a sliding bottom which slides sideways to drop the bundle. The slide is operated by foot lever control from the driver's seat.

Air Duct.

To avoid the radiator of the tractor becoming choked with trash and dirt, all intake air comes through a large-gauze covered galvanised iron duct above the tractor engine.

APPENDIX II.

QUEENSLAND CANE LOADERS.

The Toft Cane Loader.

The Toft loader (Figs. 67 and 68) can best be described by dividing the machine into (1) wheels and base frame, (2) turntable, (3) power and drive plant, (4) boom and grab. The loader is not self-propelled but is drawn through the field in various ways depending on the method of harvesting. Where trams are used either horses or a tractor provide the motive power, but when loading on to motor trucks the truck itself draws the loader behind it.

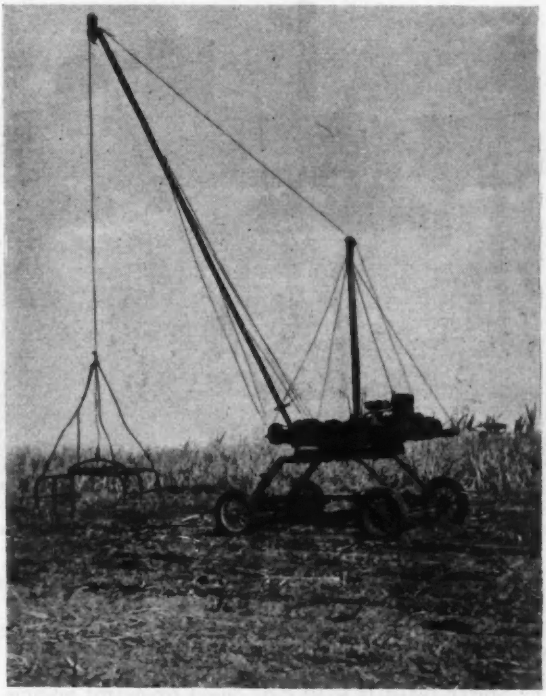

Fig. 67.—Toft loader. Boom of this model is of original type of construction. Newer models are as described in text.

(1) The four wheels are pneumatic tyred and are mounted on the conventional truck front axles. This allows the loader to be drawn from either end and since the steering mechanism of either pair of wheels can be locked by means of a centre-pin the loader can also be steered from either end. The entire base framework is of channel iron construction, being made as light as practicable, while still having the required strength to stand up to the severity of the work involved.

(2) Mounted on the framework is a large turntable which carries the power plant, the drive and clutch shaft and the boom. The turntable is capable of turning through 360 degrees, thus allowing for picking up and loading on either side or in front of, or behind the loader. The turning movement is obtained through a system of dog-cogs, two on the horizontal power shaft working on the periphery of a third on a vertical shaft. The whole turntable and framework with its accompanying power plant is adjustable so that it may be kept on an even keel irrespective of the topography of the field. This is accomplished very simply by having the framework pivoted from the centre of both front and rear axles and having the four corners of the framework fitted with crank-operated levelling screws. By winding down the two cranks on

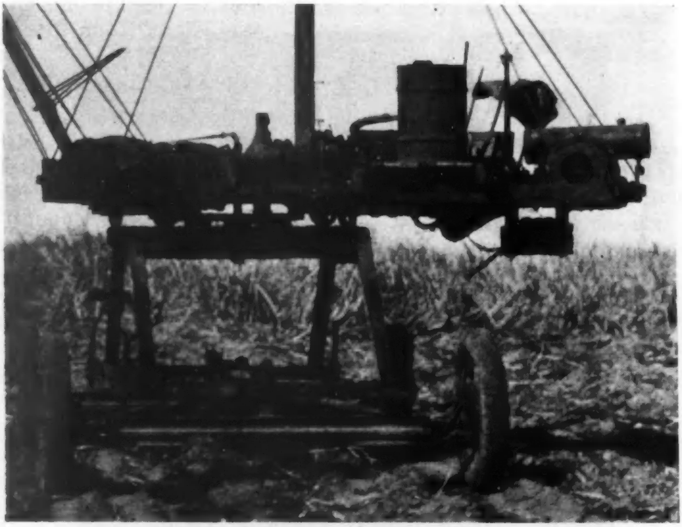

FIG. 68.—Toft loader showing fitting of turntable on base frame.

one side and winding up the pair on the other side the turntable can be kept level at all times. This levelling allows of much easier operation of the loader on uneven ground. The necessary adjustment takes only a minute at the end of the field.

(3) The power plant is a 10 h.p. diesel or petrol engine operating a common shaft. This shaft carried the boom raising clutch, two clutches for turning either way, and two for operating the grab. There are also two winding drums for taking up the cables. One of these cables closes the grab and raises it from the ground, while the other opens the empty grab and lowers it back to the ground. In operation the first drum makes a single revolution—just sufficient to close the grab on the cane bundle; a projection from this drum then engages a similar projection on the second drum, which starts it turning to take up the slack lowering cable. To release the load the other cable is tightened. thus opening the grab, which is then lowered to the ground in the open position to gather the next bundle.

(4) The boom is 25 feet long and is of fabricated steel construction. Besides having a full-circle field of operation it can be raised and lowered by means of clutch and brake operation from the power shaft. The grab follows conventional design except in regard to weight. It is all steel but weighs less than 100 lb. This eases the work of the man on the ground who guides the grab to the bundles.

As a unit the Toft loader weighs 3 tons complete. One man operates all controls on the loader, one man guides the grab when picking up bundles and a third directs the bundles on to the truck.

The Fairymead Loader.

The Fairymead Sugar Co. is using two types of loader of its own design adapted for different conditions. The one referred to in the body of this report is the large one, but both types are described in this appendix.

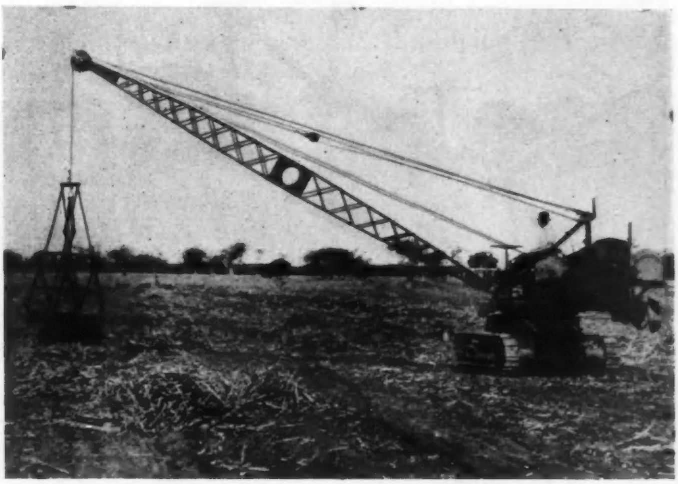

FIG. 69.—Large Fairymead loader.

The Large Loader.

The large loader, shown in Figs. 69 and 70, which is self-propelled, is generally used for loading on to tram trucks and is constructed from an I.H.C. T20 tractor (Caterpillar track type). The engine is removed from the chassis, the tracks are lengthened by three feet and are set two feet six inches wider apart. The engine is then mounted on a turntable which is built on to the tractor and the power from the engine is utilised to move the loader about the field, and to operate the turntable, boom and grab.

The loader mechanism consists of a 27 foot jib arranged for raising and lowering, slewing and hoisting. The jib and all controls, together with the engine, are mounted on the turntable. The engine is so mounted that it acts as a counterpoise to the weight of the jib and its load, thus reducing stresses on the chassis. For mobility and steering

the drive is taken down through the main pin in the centre of the turntable, while the drive for operating the loading mechanism is transmitted through clutches, &c. All motions, either of traction or loading, are controlled by an operator seated on the turntable.

The T20 engine has an excess of power and it is found from experience that a P.12 I.H.C. engine does the job admirably. The forward travelling speed of the unit is 3 to 4 miles per hour and the hoisting speed of the grab is 140 feet per minute. Lifting capacity is 20 to 30 cwt. with the jib at 70 to 75 degrees from the horizontal. The grab capacity is 5 to 6 cwt., depending on the length of the cane. When loading on to tram-trucks the handling capacity is approximately 17 tons per hour on a 20 to 30 ton crop. When loading on to motor trucks

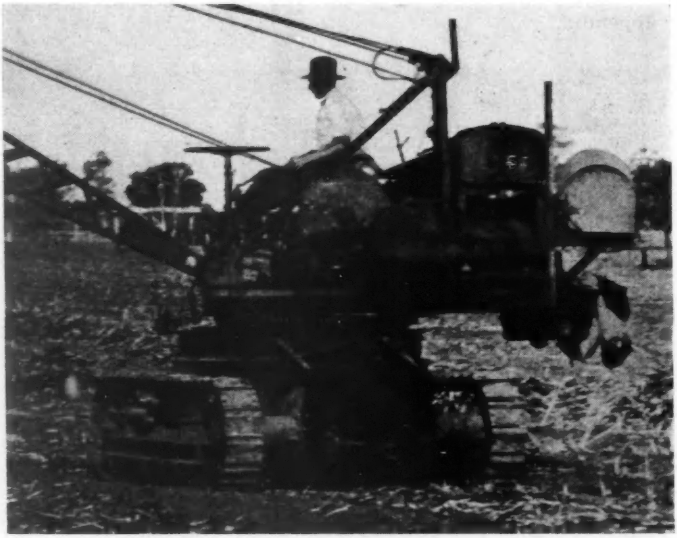

Fig. 70.—Large Fairymead loader showing the operating mechanism.

the capacity is about 25 tons per hour. The daily capacity, when loading on to tram-trucks, is dependent on the availability of trucks in a suitable position. From experience it is found that the actual working time of the loader is approximately six hours per day due to delay in shifting tramlines and providing trucks.

The fuel consumption of this unit is 1 gallon per hour with the T20 engine and ½ gallon per hour with the P.12.

In operation the machine moves forward at one side of the tramline. Ten rows are loaded on to the trucks and the machine moves down the other side of the tramline, thus loading the other ten rows. The bundles loaded by the grab are about 5 cwt., built up if necessary by picking up and dumping down until a bundle of the required size is obtained. One operator on the machine and two men on the ground to control the grab make up the team.

The Small Loader.

The small loader is designed for towing behind a motor truck which is being loaded. It is four wheeled and pneumatic tyred with no provision for steering. A turntable mounted on the frame carries the jib, clutch and brake mechanism for operating the jib and grab, and a 6 h.p. hopper-cooled engine. The jib is 21 feet long, with similar motions and controls as on the larger loader. The loader has an auxiliary drive from the 6 h.p. engine to the rear axle to assist the truck when being towed on heavy ground. The grab lifts 3 to 4 cwt. of cane but the lifting capacity of the loader is 5 cwt. with a jib angle of 70 to 75 degrees.

In operation the loader, towed behind the motor truck being loaded, picks up cane from either side. It loads about 15 tons per hour.

The fuel consumption is about three pints of kerosene per hour.

Cutter Planter Attachment for Supplying Wireworm Damaged Fields.

The cutter planter is extensively used on level farms in the Mackay district. Poor strikes, often caused by wireworms, raise the problem of supplying. Where damage is extensive and supplying is a payable proposition, cutter planters, which greatly facilitate the work, are used for this purpose. Several disadvantages have been experienced with

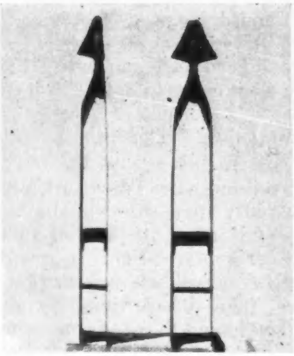

FIG. 71.—View from lower side of modified foot (left) showing straight side and half toe; normal foot on right.

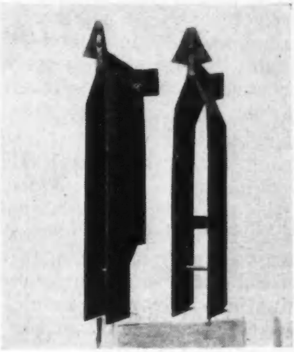

FIG. 72.—Side view of modified foot (left) showing flat side, half toe and cutaway portion; normal foot on right.

the types used, chiefly because of the need to keep a suitable distance from the original line of plants and so avoid disturbing the plants that have germinated. This disadvantage has been largely overcome by a Pleystowe grower, who has designed a modified foot (Figs. 71 and 72 left) to fit his machine.

This differs essentially from the standard foot (Figs. 71 and 72 right) in having one straight side and only half a toe. The straight side allows the foot to be operated close to the original line of setts while the half

toe does not disturb the already germinated setts. The cut away back corner seen on the modified foot (Fig. 72 left) is to permit clearance of the foot from the machine when the former is lifted out of the ground. The foot otherwise is of the same size and design as the normal fitting. Interchange of the fittings can be effected in less than two hours.

This attachment has proved very successful in planting 50 tons of supplies at the rate of one ton per acre within three inches of the original line of plants, and with very little disturbance of the soil and minimum loss of moisture. The machine fitted with the modified foot is left in the ground all the time while in the bad patches of strike and works slightly faster than normal planting with the cutter planter.

S.O.S.

A Method of Improving Germination of Cane in the Lower Burdekin.

In many cases, germination of plant cane under Lower Burdekin conditions, in 1946, was considerably delayed, and in some instances complete failure was noted because of the application of too much cover on the plants. The ample supplies of water on irrigated farms in this area have tended to influence farmers against real appreciation of the most efficient methods of conservation of soil moisture. In fact, it has become a widespread practice to plant cane in comparatively dry soil, and irrigate in the planter drills to supply sufficient mosture for germination and to pack soil about the plants. Where this method is adopted, the minimum amount of cover should be used, for irrigation will tend to make more soil fall into the lower part of the drill, and although the cover before watering may have been only one or two inches it is common to find the sett covered with five or six inches of soil after irrigation.

During cool weather the day temperature of the surface soil is generally higher than at levels four to six inches below the surface. It is obvious, then, that provided sufficient soil moisture is present, plants, with shallow cover will germinate more rapidly than those in the colder soil at a lower level. Indeed, while the buds of cane planted in cold soil are in a dormant state, fungi and bacteria may be active, resulting in rotting of the sett before conditions are favourable enough to promote germination. Growers should therefore take precautions to avoid excessive cover of cold wet soil over the setts, and if necessary remove it without undue delay.

The shape of the drill in cross section may have a very considerable influence on the final cover on plants. It has been noted that many planting machines have the drilling mouldboards cut away at the rear end and in soil of good tilth the resultant drill forms an acute angle above the plant. A slight modification to the mouldboards will produce a drill of the same depth with a flat bottom in which cultivation implements will work more satisfactorily. Furthermore, soil falling into the drill with irrigation water will cause only a small amount of additional cover on the plant in a flat bottom drill, whilst in a V-shaped drill the same amount of soil may bury the plant to a considerable depth.

G.A.C.

A. H. TUCKER, Government Printer, Brisbane.